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ABSTRACT

The 26 papers in this collection present the history and organization, system components and techniques, social aspects, and economics of telecommunications development in Alaska, with special emphasis on the growth and use of satellite systems. The first five papers cover developments beginning when Alaska was still Russian-owned, and also discuss the organization of the state government with respect to telecommunications. Six more technical papers then describe the existing system and techniques, including the small earth stations largely responsible for stimulating telecommunication developments in rural Alaska and the local exchange development that depends upon long-lines services from those stations. Social benefits in the areas of medicine, education, governmental participation, and information access are discussed in six papers. Papers in the television category include a set of instructions for bringing new technologies into native communities. Three papers pertain to economic factors in telecommunications, mostly confined to Alaska. The collection ends with an historical summary and speculation regarding Alaska's future in telecommunications. An appendix provides Alaskan statistics. (Author/LMM)

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Telecommunication in Alaska

Edited by Robert M. Walp

Papers in Support of the Alaska Case Study Presentation to the 1982 Pacific Telecommunications Conference

January 17-20, 1982,
Honolulu, Hawaii

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Telecommunication in Alaska

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FOREWORD

This collection of papers covering many aspects of telecommunication in Alaska evolved as a by-product in planning for the Alaska Case Study presentation for PTC '82. As a member of the Conference Committee, I had convinced my colleagues that our experiences in trying to accelerate development of telecommunication services in Alaska would be of substantial interest to the general body attending the Conference. After that success it was evident that I was committed to see that a credible presentation was put together. Planning for the Alaska Case Study was done through a series of teleconference meetings attended by many of the authors in this volume, at several locations in the State. I happened to be in the eastern part of the United States at the time one of the meetings was scheduled, so I participated by using the teleconference facilities at the Legislative Information Office in Washington, D.C. I mention this only as an example of the utility of one of the services that is covered in the papers.

While planning the one-hour Case Study presentation we listed tentative subjects to be included and soon realized there was far more than could be covered in the allocated time. We considered preparing a few background papers to be included in the Conference Proceedings as an appendix to the Case Study; the idea has now evolved into the present concept of collecting a diverse group of individual papers and bringing them into a single, separate, volume.

Before discussing the nature of the papers it seems appropriate to briefly describe the State of Alaska and make a few comments regarding the status of its telecommunication development. Some of the papers also contain similar information, however I feel it should also be included in this introductory section and apologize for the redundancies.

Alaska is the largest political subdivision of the United States. It has a land area of approximately 1 500 000 km^2 and its extreme distances are 2 200 km in a north-south direction and 3 600 km west to east. The state is characterized by rugged terrain and harsh climate and very low population density. In many respects, Alaska is similar to the less well developed nations in that it has had very little transportation or communication infrastructure. It is generally exploited for its resources which are exported outside the state. There are many small and isolated native villages currently in transition from a subsistence to a cash economy.

Because of the extreme distances and small population, the development of terrestrial telecommunication circuits has been limited. Not until communication satellites capable of working into relatively small earth stations became available was it possible for reliable telecommunication services to be made available on a statewide basis.

Little over ten years ago all long-lines communication services were provided by the military; now, as in the rest of the United States, they are supplied by private companies. It has taken, however, substantial advocacy and funding support from the state government to stimulate the development of a network of small earth stations to bring long-lines telephone circuits into rural communities.

Television is being brought into the state on a timely basis for the first time by satellite (formerly, videotapes were shipped from the lower 48 states) and distributed to rural communities through the small earth stations for entertainment and instructional purposes. The great distances and high cost of travel have led to the extensive use of teleconferencing for administrative and legislative meetings. Electronic mail is being used regularly throught the state government.

In forcing the development of telecommunications faster that it might have naturally occurred, many economic and institutional issues have been highlighted in a manner that otherwise might not have happened. Considerable review of the role of the state government in an enviornment where services are provided by commercial firms has led to changes in organization that should be of interest to other administrations.

The progress that has occurred over the past decade resulted from the efforts of relatively few individuals of which many are authors of these papers. Not everything has gone smoothly; classical conflicts between the public and the private sector have surfaced. Plunging into programs before doing adequate planning has occurred and has caused problems. At other times studying the same issue over and over, by a succession of new "experts," has consumed large amounts of time and money and has often impeded action. Where progress has been made in Alaska we have generally erred on the side of doing, rather than planning, largely because of impatience to meet sharply felt needs and also because the funds were quickly appropriated. Fortunately, a growing public awareness coupled with the concern of decision makers for the situation of the end users has helped avert potential disasters, at least in most cases. Much effort was expended in involving users in the planning process, often on a crash basis due to the small amount of time available. While the bureaucrats and the businessmen in their centralized offices generally do have a good understanding of the needs at the end of the line, the people out there really know what they want, if they are given a chance to learn of their choices. If they are consulted and become involved in planning innovative services they are certain to be more satisfied, and this is to everyone's benefit.

As the Pacific Telecommunications Conference draws persons of many disciplines from many countries of the Pacific Region and elsewhere, we had hoped to emphasize aspects of the Alaska experience that would interest the PTC audience in general. I am not sure we have completely succeeded for some papers are very narrowly specific to Alaska; they have been included, however, for the volume turns out to be a reasonably thorough summary of activities in the state and can serve purposes other than those of the PTC. Certainly some of our situations closely parallel those of other countries and others are in extreme contrast. In either case there may be something of value to others. We hope so.

Most of the papers are by those who are or who have been directly involved in efforts to improve the telecommunication scene in Alaska, as opposed to the few written by academic researchers in their role as observers and commentators on our efforts. In certain areas there is some repetition - there are many common threads throughout. There are some contradictions in viewpoint; these may be stimulating. There are also contradictions in fact (mostly regarding the number of native Alaskans living in the bush), but I believe they are all inconsequential. You will notice many versions of what we refer to as Paragraph A, the reference to "Alaska's vast size, rugged terrain, harsh climate and sparse population," which I have already touched upon and which seems to precede anything written about our State.

I regret that it has not been possible to include a map with enough detail to show the true nature of the State with all of the places named in the various papers. An excellent full-color map, approxmately 60 cm by 80 cm, is available in plastic, for $4.00 U.S., post-paid internationally, from the National Geographic Society, Washington, D.C. 20036, U.S.A. Please ask for the Close-up USA map of Alaska. Only those who are totally uninterested should ignore this opportunity.

The papers are arranged in somewhat of an historical manner and are also grouped along broad subject lines. The first five, by Hills through Plummer, cover developments beginning when Alaska was still owned by Russia and also discuss the organization of the state government with respect to telecommunications. The introductory paper by Alex Hills was prepared for the conference proceedings; it is incorporated here for completeness.

Harry Mitchell, co-author of the paper on military communication in Alaska, is truly in the Pacific Ocean on the sailing cutter Windsong, on a five- to ten-year circumglobal trip with his wife, Marge. They will be sailing all over the Pacific during the next several years. Harry might be available for consulting in telecommunication matters during their stopovers, so keep an eye out for the Windsong!

Papers 6 through 11 describe the existing systems and techniques and tend to be more technical than the others. Shaginaw's is also reprinted from the proceedings. Dowling describes the small earth stations that were largely responsible for stimulating most telecommunication developments in rural Alaska. Batra discusses local exchange development that depends upon long-lines services from the small earth stations.

The next group, from Goldschmidt through Taylor, cover subjects with a social benefit theme; medical, education, governmental participation and information access. Baltes describes the very effective way that the State Legislature is improving its contact with the public. Taylor, in a paper originally presented at PTC '79, discusses a concept that could give citizens in isolated communities access to information and communication resources at affordable prices. It is reprinted here because I am particularly enthusiastic over this Community Information Center concept which has, so far, failed to materialize in the form described.

Television is the subject of the papers by McIntire through Uchitel. Frampton's casually subjective advice is a refreshing set of instructions for bringing new technologies into native communities. Written specifically for the Alaska scene, his paper shows the concern that was implicit in this effort to introduce television in the bush. The broad concerns, if not the details, apply elsewhere and possibly everywhere.

A trio of papers by Allan, Mansell and Melody pertain to economic factors in telecommunications, mostly confined to Alaska. Mansell is concerned over the effect of subsidies on telecommunication development. Allan and Melody address the problem of obtaining rate equity in parts of a system where cost differences are great, typical of the multi-company situation in the U.S. Although these papers assume communication services are supplied by government-regulated private monopolies (now being subjected to the inroads of competition), the methodologies and devices that have been invented to make the system work tend to bring forth issues that might otherwise be overlooked. As an example, Melody discusses the contribution of local exchange plant to long-distance calling, a

factor not likely to receive much attention when one agency owns and operates all communication facilities, yet it is important to the internal planning and funding process. It is interesting that, in discussing the revenue shortfall in Alaska, Allan calls it "significant" in terms of the total Alaska market. Melody, however, points out that it is negligible when compared to the overall U.S. market. This emphasizes the importance of a national policy if all parts of the country are to receive equivalent services at uniform prices.

Finally, Blume and Browne close this collection with an historical summary, comments and speculation regarding Alaska's future in telecommunications. I hope that somewhere within this publication there will be a few papers, and possibly many, that will appeal to each person perusing it.

Illness, other committments and just plain unwillingness to contribute have cheated us of four or five papers I would liked to have seen. I do want to thank the authors who prepared papers specifically for this project and point out to the reader that, because of the nature of this effort, the authors will not have the pleasure of presenting their work before the conference.

Charity B. Kadow, Director of the Division of Public Services of the Legislative Affairs Agency, deserves acknowledgment and credit for allowing us to use the Legislative Teleconference Network for our several meetings. Without that privilege it would have been difficult to organize the Alaska Case Study presentation and impossible to attempt this publication.

Finally, Richard Barber, Director of PTC '82, deserves special thanks for his encouragement, suggestions and support for this project; most of the good ideas were his.

Anchorage
26 November 1981

Robert M. Walp

History and Organization

THE CHANGING STRUCTURE OF ALASKAN TELECOMMUNICATIONS

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Abstract

Alaskan telecommunications facilities have been significantly expanded and improved since 1970. Telecommunications structure, within both government and industry, has become an issue in Alaska, and structural changes are occurring. In 1981, for example, the telecommunications functions of State government were reorganized. Telecommunications facilities have generally been moving from government to private ownership, but at least one major ownership issue remains.

(Film on telecommunications development in Alaska precedes presentation.)

As you have just seen, Alaska has, in the past decade, made considerable progress in telecommunications. In 1970 the large majority of Alaskan communities had no telephone service, no radio broadcast service, and no television broadcast service. Today virtually every community has telephone and radio broadcast service and many communities also have television. Most communities will have television broadcast service within the next two years. In many instances, advanced applications of telecommunications are also in use. Examples are electronic mail, computer assisted instruction and two separate audio conferencing networks.

In addition to the what of telecommunications, we are now beginning to give a great deal of consideration to the how of telecommunications. Where in the seventies we have been very much concerned with applications and facilities, we are beginning the eighties additionally concerned about the process of telecommunications development and the structure of our institutions and organizations. Areas of specific concern are:

- government structure
- industry structure
- economics

We are coming to realize that the process is as important as the product because it is the process that makes the product possible.

STATE GOVERNMENT STRUCTURE

Effective July 1, 1981, the telecommunications functions of the government of the State of Alaska have been reorganized and brought together under one department. These functions had previously been located within a number of different agencies. The reorganization, effected by Executive Order 50, reflected the need to:

- streamline the management of telecommunications
- institute a planning function
- Make assistance and coordination service available to State agencies

Under the reorganization, telecommunications functions are now located within the Department of Administration. Data processing functions are located in the same Department, and this is helpful where we have common problems. Further, we are well positioned for the merger of the communications and computer technologies.

Executive Order 50 placed all telecommunications under one person, a Deputy Commissioner of Administration. I hold that position and report to the Commissioner of Administration, whose responsibilities include a number of other areas. Reporting to me are two telecommunications divisions, an operations division and a planning division. The Alaska Public Broadcasting Commission is also attached to the Department of Administration.

Our operations division is responsible for the design, installation, and maintenance of essentially all telecommunications systems operated by State government. These systems range from data communications to State Trooper VHF radios to our statewide satellite television project. The division has 55 employees, with technicians located around our large state at a number of field locations.

The planning division is responsible for both short- and long-range planning, technical assistance to State agencies and other organizations, and coordination of State telecommunications functions. The division assists agencies and groups which have needs but don't quite know how to deal with them. It is available to provide assistance, suggest options, and develop cost figures.

The creation of the new planning division reflects our recognition of the need for a strong telecommunications planning function. This division will enable us to:

- effect needs assessment and facilities planning on a coordinated and unified basis
- implement a cost-effectiveness approach to planning
- anticipate both needs and problems, so that "firefighting" solutions can be minimized or eliminated

Establishment of these goals in Alaska is a major new development.

Within its first few months of operation, the planning division has started two major projects. One is a comprehensive plan for development of telecommunication services to State government. This includes telephone, data, audio and video services. The plan is to be complete in July 1982. The second is an examination of alternatives to State-funded rural television. This project, which is discussed further below, is scheduled for completion in early 1982. In addition, planning efforts in the area of instructional telecommunications and in the area of teleconferencing are scheduled to begin soon.

INDUSTRY STRUCTURE

As you know, we in the United States are now involved in deregulating portions of the telecommunications industry and in a general move in the direction of increased competition. Specifically, competition is on the rise in the telephone industry in the areas of terminal equipment and message toll (long distance) service. In broadcasting, alternatives to conventional television broadcasting are quickly becoming available (cable, direct broadcast, subscription television) and we have competition between the various technological delivery vehicles. Deregulation and competition are coming through the Communications Act Rewrite presently pending before Congress, through a number of actions by the Federal Communications Commission, and through the availability of new technology.

Although these changes are not unique to Alaska, they are of particular concern to us, especially in the area of telephone service. Unlike most of the United States, Alaska has a telephone network that is still in need of considerable expansion. Where most of the nation has achieved virtual universal availability of telephone service, Alaska has not yet reached this goal. Most of our communities have only one telephone each. The situation is improving rapidly, but proper economic conditions are necessary for continued improvement.

Rural telephony is, by nature, an economically marginal enterprise. Because subscriber densities are low, the cost of serving each subscriber is high. In our nation we have two mechanisims to offset this high cost, a low interest loan program administered by the Federal government, and the mechanism by which toll, or long distance, revenue is divided between carriers. These "toll settlements" provide a great deal of revenue to rural local exchange companies. Although low interest loans and toll settlements constitute subsidies of sorts, they appear justified by the national interest in universal service. It is beneficial to all citizens to have telephone access to all other citizens.

Both of the mechanisms which boost rural telephony are presently threatened. The low interest loan program may fall victim to Federal budget cuts, and toll settlements are likely to be reduced by deregulation. Deregulation of terminal equipment will remove such equipment from the base used to compute toll settlements, and in order to accomodate message toll competition, the toll settlements formulae will likely be changed. Both of these changes will reduce toll settlements.

One good solution to the toll settlements problem is contained in the Communications Act Rewrite presently pending before Congress. Called the "universal service pool," it is specifically designed to keep rates in high cost rural areas at reasonable levels. The universal service pool would be derived from a surcharge on toll charges nationwide and would be used for direct subsidy payments to high cost rural companies. The arrangement would accomodate toll competition and would also keep rural rates at reasonable levels.

Within our State telecommunications organization, we are continuously monitoring the status of changes at the Federal level. Where appropriate, we are attempting (often successfully) to influence those changes, for we are finding that we need to look after our own interests - no one will do it for us. The help of our Congressional delegation in Washington, D.C. has

been invaluable in this regard.

Another aspect of the changing industry structure in Alaskan telecommunications is reflected in the ownership of facilities. Since 1970 we have been moving away from government ownership and toward private ownership. Each major move in this direction has been the result of a decision by government.

Alaska's long distance telephone facilities were operated, until 1971, by the Alaska Communications System (ACS), an arm of the United States Air Force. The Air Force facilities had been constructed primarily to support radar stations located in Alaska but were used, in addition, to handle civilian telephone traffic. In January 1971, the ACS was purchased by RCA Alaska Communications, Inc. (RCA Alascom) as the result of an Air Force decision to divest itself of this system. In 1971, RCA took over all of the service the Air Force had provided to civilians in Alaska. RCA Alascom, which later was sold to Pacific Power and Light and is now known as Alascom, has developed and expanded the network in many ways, some of which you have seen in the film. The course of telecommunications development in the seventies has not always been smooth, and some of our progress has been the result of State action, but the development has happened with our telephone facilities, like those elsewhere in the United States, in private hands.

One of the rough spots occurred in 1975 when, after RCA's refusal to do so, the State decided to make a major commitment to satellite communications. The State purchased 100 small earth stations (4.5 meter antennae) for installation in Alaskan villages. RCA was given an opportunity to participate in the project and did eventually install all of the earth stations. The company has since operated and maintained the earth stations as a partner of the State. Ultimate ownership is to be decided by the Federal Communications Commission (FCC).

The State of Alaska has announced its intention not to seek final ownership, but, in the meantime, some of the local telephone companies serving Alaskan villages have filed for ownership of the earth stations within their service areas. Thus, Alascom and the local companies are now in contention for ownership, but, regardless of how the FCC decides the question, the earth stations will soon be in private hands. This outcome will be consistent with the structure of the telephone industry elsewhere in the United States.

Yet another ownership question is before us now. The State in 1976 initiated a Satellite Television project to provide television broadcast service to rural communities which, at that time, appeared to have no other possibility of receiving television service. The project now serves 94 communities, and another 119 will have service by 1983. Under the project, the State owns and operates low power transmitters and receive-only earth stations in some communities. In other communities the State owns only the low power transmitters and purchases earth station services from Alascom. Programming is derived lartely from the three national commercial television networks and from the public television network. As a result of these arrangements, the State is providing a service normally provided in the United States by the private sector. The project is possible only through the cooperation of the commercial networks and their Alaska affiliates. It is very popular in rural Alaska.

Recently, some purveyors of television service in rural Alaska, cable television and low power subscription television operators, have taken exception to State operation of rural television. Simply stated, these companies object to competition from the State. At the same time, these private sector operators are far from willing to provide service to all of the State's communities.

Thus, a very perplexing problem faces the State at this time. Is it possible to accomodate rural television service by the private sector and, at the same time, insure that service is available to all Alaskan citizens? The answer to this question may lie in direct satellite broadcast, in cable television, in low power subscription television, or in a combination of all three. The rural television question is the subject of a major effort within our telecommunication planning division. The work is scheduled for completion in early 1982.

CONCLUSION

We continue, in Alaska, to be interested in telecommunications facilities and applications, but we are equally concerned with the structure of our telecommunications institutions in both the public and private sector. In the public sector, we have taken a major step to improve our management and planning functions. State government is concerned with fulfillment of its own needs but also of public needs. We are moving telecommunications from the public to private sector to the extent compatible with service that is universally available to Alaskan citizens.

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ALASKA TELECOMMUNICATIONS

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Abstract

Alaska's communication services have ranged from the most primitive to the most advanced technology. State and Federal agencies, private individuals and commercial corporations have contributed to the growth and development, of our present system and will participate in continued leadership in applying telecommunication technology to the needs of our future generations. Many years of substandard communication service have been relieved by modern technological innovation, particularly the availability of geostationary satellites and the earth station access to these systems.

INTRODUCTION

The State of Alaska with a population just over 400,000, has a land area greater than 500,000 square miles. Alaska extends north-south over 1500 miles and east-west over 2500 miles, most of which is north of the 60th latitude. The small population is comprised of several ethnic origins that developed similar lifestyles to cope with the harsh climate. Almost half of the population lives in the vicinity of the largest city, Anchorage. The remaining people live in the ten larger communities of over 3000 or scattered in 150 villages with populations between 25 and 3000. The average distance between villages is approximately 60 miles with some villages more than 150 miles from their nearest neighbor. Most are not connected by roads.

On several occasions Alaska has been in the forefront of innovative communications systems and yet has been lacking in the basic needs of its citizens for adequate communications (3). As an example, in the early 1850's, after several attempts to lay a transatlantic telegraph cable had failed, some Americans initiated an effort to establish a telegraph line to Europe by going west through Canada and Alaska, across the Bering Straits to connect with the Russian telegraph line in the Amur River Basin. Surveys had already begun when the transatlantic cable was finally successfully completed and the Russian project abandoned. One of the early supporters of the transalaska telegraph system was William H. Seward who later became Secretary of State and arranged for the purchase of Alaska in 1867.

Further progress in Alaskan telecommunications had to wait until the early 1900's when the U.S. Army Signal Corps began construction of a telegraph line through the territory. Shifting ice destroyed submarine cables in one section along the coastline. As a result, in 1903, the Army developed a 100-mile radio-telegraph link to replace the destroyed section. This was the first application in the world of this type of communication link. Other than the development of high frequency (HF) radio circuits, very little occurred in Alaskan communications until the Second World War.

During the War, a 1500 mile gravel road was completed from Dawson, Y.T., Canada to Fairbanks and Anchorage. Along the "Alaska Highway", open wire telephone lines were installed to Seattle, Washington; southeastern Alaska was connected to Seattle by an undersea telephone cable. The U.S. Army Signal Corps developed and operated the Alaska Communications System (ACS) principally for the military traffic and other government communications. Civilian communication was given low priority and long waits for long-distance (toll) circuits were common. High frequency radio circuits were expanded in all parts of Alaska for point-to-point communication. Large Rhombic antenna arrays were built by ACS throughout Alaska and in the Seattle area.

Following the war the development of the Distant Early Warning (DEW) line of radar stations along the western and northern shores of Alaska and across Canada required an enormous increase in the communication capability between Alaska and the "lower 48 states". The communication expansion was accomplished by combining several different systems. Along the relatively few miles of road a TD-2 microwave system was constructed linking Fairbanks, Anchorage, and the Kenai peninsula. The long distant communication links over impossible terrain or between islands of the Aleutian chain were accomplished using the tropospheric propagation mode of transmission. The high power transmission signal, usually from 300 to 4000 megahertz (MHz), was scattered off irregularities in the atmosphere at tropospheric heights. The forward scattered energy was then received several hundred miles beyond the horizon. Very large antenna were required for transmission and receiving, i.e., 60 to 120 foot in diameter, and since

the scattering occurred over a relatively large volume, plane-wave antenna gain was not achieved in this mode. Multipath fading was, in general, a Raleigh distribution function and was considably reduced by both space and polarization diversity.

Statewide communication was connected to a microwave transmission system constructed along the route of the Alaska Highway through Dawson and then continuing to the U.S. border at Sweetgrass, Montana, where the Canadian portion connected with the A.T.&.T. system. This "rearward" communication system provided Bell system standard voice and data circuits for the first time to a large portion of Alaskan population. Most small village communities, however, were still isolated from the integrated communication network. They relied on HF radio which due to the highly disturbed ionosphere over Alaska, has a reliability between 12 and 15%.

The high-latitude regions in general and Alaska in particular, are probably among the most difficult regions of the earth to establish and maintain reliable, economical radio communications systems. Extremely rugged terrain features, wide variations in surface conductivity, and great variability in the radio frequence (RF) propagation properties of both the nonionized and ionized atmosphere profoundly affect radio propagation. In lower latitudes where the ionosphere is relatively stable, a radio signal may be transmitted that will be high enough in frequency to be only slightly absorbed yet low enough in frequency so that it will be reflected from the ionosphere back to earth at the distance required for communication. The ability to change the frequency of the transmitter to adjust for the above requirement is essential to continuous communication. Even with this ability and extensive instrumentation along the radio path to measure the ionosphere, it is often impossible at high latitudes to sustain continuous communication over HF radio circuits.

THE AURORAL ZONE

In an oval region roughly symmetrical with the earth's magnetic poles, the ionosphere is often highly disturbed because of complex interactions between the earth's magnetic field and the particle flux continuously emitted by the sun. The solar particle flux, called "solar wind", changes continuously depending upon the conditions on the sun's surface.

Ionosphere absorption events in the central and northern portion of Alaska are identified with three types of solar radiation. Solar flares produce electromagnetic radiation that reach the earth in a few minutes and produce ionospheric absorption on the sunlit side of the earth. At the same time very high energy particles projected into space may reach the earth's orbit in about one and a half hours. These particles are deflected by the earth's magnetic field over the entire polar cap, extending even as far south as Fairbanks, Alaska. The particles penetrate to about 50 kilometers altitude and result in intense ionization in the lower ionosphere. This results in a strong absorption of radio waves that may persist for several days. The high energy but relatively low density particles are often followed by a much higher density, low energy cloud of particles that travel from the sun to the earth in about 36 hours. This slower particle radiation distorts the earth's magnetic field in space and gives rise to large magnetic disturbances and aurora.

During periods of great activity, the charged particles moving in the upper atmosphere constitute large currents whose magnetic fields extend to and into the earth. Hence, these phenomena are known as "geomagnetic storms". During these storms, magnetic compasses are disturbed. As the currents change, the changing magnetic flux linking the earth induces voltages which result in differences of potential between different points of observation on the surface of the earth. Potential differences of the order of 2 volts per mile are sometimes observed. Even with the latest equipment and high-power transmitters, using the HF radio band will be unpredictable and subject to extended periods of communication failure.

SATELLITE COMMUNICATION

Alaskans have been tracking satellites and developing satellite communication since about one hour after the Russian Spudnik I was launched twenty-four years ago. A radio-star tracking facility at the University of Alaska Geophysical Institute was converted to a satellite tracking station in a few minutes. The Russian satellite, at an altitude of 200 km and an orbit inclination of 65°, was ideally located for our continuing research into the electron density in the aurora. The University was awarded a contract by the National Aeronautic and Space Administration (NASA) to design and install a mini-tracking station and the first NASA 85-foot monopulse tracking system was installed at Gilmore Creek, north of Fairbanks.

In 1966, NASA launched the ATS-1 satellite into geostationary orbit. This satellite had a number of experimental programs and multiple transmitters on board. One of the systems was a VHF narrow-band transponder. The up-link center frequency was 149.22 MHz with a corresponding down-link frequency of 135.6 MHz. In the 1950's it was generally accepted that frequencies above 30 MHz were "unaffected" by the ionosphere. Data obtained in Alaska proved that this was not true. Radio-star data showed that at 223 Mhz, scintillation of the radio wave passing through the ionosphere were greater than 15 dB and at 456 MHz greater than 7 dB scintillation fading was observed (2). In 1968 the University faculty were asked to evaluate the feasility of using the VHF transponder on ATS-1 for communication into

Alaska's remote areas. Calculation indicated that when the ionospheric disturbances were at a minimum satisfactory communication could be maintained. However, during disturbed magnetic storm periods, severe scintillation would make communication difficult to impossible. Fades of as much as 30 dB were predicted. Permission to begin transmission to ATS-1 was provided by NASA and an experimental license was obtained from the FCC. Testing was continued through September and October to evaluate the channel using modified 100 watt taxi radios and a handmade wideband helix transmit/receive antenna.

During the testing period we had a strong magnetic storm with bright, visible aurora directly in the radio path to the ATS-1 satellite. Scintillation in excess of 30 dB fading was observed. The ionozation bands were continually moving so by waita few minutes, communications could be re-established. Even during the most disturbed time, by the procedure of transmitting "words twice", complete communication was demonstrated. The Public Health Service (PHS) personnel in Anchorage were invited to try the satellite system to provide emergency medical communication into selected villages in interior Alaska. They were very enthusiastic. Thus, transmitters and receivers were temporarily installed in Allakaket and Venetie. The base station was at the Electrical Engineering Department Laboratory on the University campus at College, Alaska.

The ATS-1 satellite circuit worked so well that PHS wanted the system extended to a much greater number of villages. The National Library of Medicine, Lister Hill Center for Biomedical Communication, provided funding to allow expansion of the program to 23 villages. Most of these villages were in the Tanana district of interior Alaska which covers about 200,000 square miles. In this expanded program, a local person, usually a native woman, would receive a few weeks of training in emergency medical procedures and patient care. They would then consult daily with the regional doctor by HF radio. This doctor-call program with the health-aide and the regional physician was extremely successful but limited by the availability of HF radio communication.

In 1974 the University secured a contract with PHS to analyze the communications problems in the Bethel district. About 50 villages communicate with the Bethel Native Service Hospital (PHS) for their medical advice and consultation. The Bethel district encompasses approximately 100,000 square miles on the West coast of Alaska and Kuskokwim River drainage with roughly 100 miles of road. It was determined after careful study of the possibilities of VHF mountain-top repeaters and other communication options that the most cost effective and reliable method of providing this communication was by satellite. The conclusions, in a report to HEW, specify that 10-foot diameter antennas operating into an appropriately configured satellite would provide communications to all 50 villages in the Bethel district. The original design of the basic earth station was later expanded to include a public access message telephone service (MTS) in addition to the PHS doctor-call emergency medical capability. The earth station design was later modified to include a 4-1/2 meter antenna, a low noise, gallium-arsenide field-effect transistor preamplifier; and a single carrier per channel system providing two channels and expandable to eight channels without adding additional cabinet space. The transmitter selected was a 40 watt traveling-wave tube.

ALASKA TELECOMMUNICATION POLICY AND PLANNING

For many years the telecommunication needs of the State of Alaska were handled on a part time basis by private citizens and state employees with other full-time jobs. During the administrations of Governors Hickel and Miller, communication was the part time responsibility of the Secretary of State (now the Lt. Governor). When Governor Eagan was returned to office in 1970 the Director of the Division of Communication served in an informal advisory capacity on telecommunications. The newly created Alaska Educational Broadcast Commission (AEBC) formed a Telecommunications Advisory Committee (TAC)that brought together experts from the public sector to advise the AEBC and the administration on policy and planning for State needs. Mr. A. G. Hebert of Anchorage volunteered several hundred hours to coordinate the TAC program. By 1974, Governor Eagan had appointed a fulltime advisor on telecommunications. When Governor Hammond took office in 1975, he established an Office of Telecommunications Policy with a director and several assistants. This office functioned until 1979 when it was terminated and the responsibility moved to the Department of Administration under the Deputy Commissioner of Telecommunication.

During the middle fifties, the Air Force was given responsibility for operation of ACS and by 1969 the federal government decided to sell the portion of the ACS facility that was providing most of the non-military services. Several companies submitted bids to purchase the system and hearings were held to determine the qualifications of the bidders and the proposed improvements to be added to the existing system. The State administration requested that special attention be focused on providing improved communication to 144 remote villages.

RCA was awarded the right to purchase the system and after further hearings before the Alaska Public Utilities Commission, was awarded a "certificate of convenience and necessity" as a common carrier serving the State of Alaska. The plan to provide service to the 144 "bush" communities included the construction of thin-route microwave throughout the region with VHF extention to the villages using the obsolete IMTS radiotelephone system. All of the villages were to be connected to the telephone system within three years. At the end of the three years, less than 50 villages were in service and the system was completely over-

loaded.

The private sector of the state telecommunication community was involved in the planning and implementation of other NASA-HEW experimental programs including ATS-6 and the CTS satellite project. They continue to be an active voice in the current planning and policy making of the State.

DOMESTIC SATELLITE HEARINGS

When the domestic satellite docket was proposed by the Federal Communications Commission (FCC) nine companies responded by submitting material requesting permission to operate domestic satellite systems. Of these nine companies, RCA, MNCI Lockheed, A.T.&.T., Western Union and several others, prepared a presentation for the Alaska legislature. Governor Miller had earlier asked the FCC for the right of Alaska to intervene in these hearings. This permission was granted and Alaska actively participated in the deliberations and has done so ever since. Hawaii also presented a statement prepared by the Governor which was well researched and very comprehensive in its analysis of Hawaii's situation. Legislative hearings held in Alaska were attended by all nine companies who were vying for position in the domestic satellite market. Their presentations were evaluated by a panel as to their impact on Alaskan communications. At the request of the Governor, these materials were then presented to the FCC by the Attorney General. This document indicated that none of the satellite proposals were specifically directed toward Alaska's requirements. Several of the proposed systems were suggesting 24 and 48 transponders and 12 and 14 Gegahertz frequency use that appeared at that time to be third generation satellite design which would not be available for ten years. The RCA SATCOM I and SATCOM II satellites developed from these designs included 24 transponders with orthogonal polarization frequency reuse.

OPERATIONAL PROGRAMS

Alaska is primarily interested in establishing operational telecommunications facilities. The Legislature mandated that there is a most urgent need to ensure that all communities with a permanent population of 25 or more receive adequate telephone service. To achieve this goal, a program employing satellite communications to meet fundamental needs was initiated in 1975. The basic need was to provide a voice circuit for emergency medical service plus a message telephone circuit for public use.

The design of the system was largely determined by the characteristics of the communication satellites which were available. The existing satellite earth station system was optimally designed for more general use in the contiguous United States. The satellite transponder design was originally intended for use with high-sensitivity earth stations employing 10-meter and larger diameter antennas. The Alaska system design would use smaller antennas in all but the largest communities in order to make it economically feasible to locate earth stations at each village. At the special request of the State of Alaska, RCA modified their satellites F-1 and F-2 to provide more amplifier gain through the satellite and adjust their antenna feed-horn to increase the radiated power directed toward Alaska for 6 of the 24 transponders on board each satellite. Using large earth stations would limit the number that could be constructed, making it necessary to link many villages via VHF or thin route microwave circuits to the nearest earth station. The initial cost of utilizing this "cluster concept" to provide basic service to all communities would have been greater; adding more circuits would have been difficult or impossible to accomplish. The cost of supplying television to small villages is much less with the small earth staions approach whereas it would have been prohibitive if only large earth stations and the cluster concept were constructed because of the high cost of terrestrial video distribution.

The earth station design evolved from the Bethel PHS study. Voice transmission is accomplished by frequency modulating a specific carrier for each channel. Earth stations in the smaller villages were equipped with two circuits: (1) a conventional message telephone circuit, and (2) a special circuit for emergency medical service. Expansion up to eight circuits could easily be accomplished through the insertion of additional circuit modules to supply enough trunks to service a community of several hundred with a local telephone exchange. In villages with no existing telephone service, a single instrument was located in a central building accessible to the public. The use was generally monitored by an attendant. At this time 110 small earth stations have been installed.

The carrier frequency for each circuit in every earth station is unique and preassigned. All circuits are routed through the satellite to a major earth station and then to a switching center in Anchorage. Thus , calls between villages must be transmitted through the satellite twice. This "double-hop" transmission is annoying due to the increased propagation delay (approximately 0.6 seconds); it also utilizes twice the satellite bandwidth, reducing the number of simultaneously available channels by a factor of two. If a channel is not being used by the station it is assigned to, it cannot be used by any other station. Traffic characteristics require that, in a preassigned system, a large fraction of channels will generally be unused. Demand Assigned Multiple Access (DAMA) techniques will be utilized in the future to eliminate these problems. In the DAMA system no frequencies are assigned to any earth station on a permanent basis. Instead, frequencies are automatically assigned to channel units only when necessary to establish a circuit to meet a specified need. Digitally-controlled frequency synthesizers are programmed by channel selection logic to allow single-hop transmission directly between any two stations. Traffic statistics are such that use of DAMA gives five to fifteen times the effective circuit capacity as can be obtained

through fixed-assignment (1).

TELEVISION DEMONSTRATION PROGRAMS

A program to demonstrate the capability of the small earth stations to receive quality color television programming via satellite for entertainment and educational purposes was conducted for several years. The alternative to supplying television programming by satellite is to mail pre-recorded videotapes to the village television transmitter sites. Satellite distribution is favored for large numbers of sites and greater numbers of programming hours. Twenty-three rural villages were initially equipped to receive video signals from the RCA F-2 satellite transponder dedicated to Alaska television transmission. Audio was originally received through the SCPC equipment via the transponder used for telephone service. The audio is now transmitted as a subcarrier with the video signal.

In order to obtain the best compromise between signal quality and margin above FM threshold at the small earth stations, a deviation less than optimum for more sensitive earth stations (10 m diameter) was used. The quality of the received signals exceeds that required for excellent viewing. Ten watt "mini-TV" transmitters are employed to broadcast programming in the villages. These low-power transmitters have a range of three miles or greater, more than adequate for the typical village.

The morning hours are utilized by the Department of Education and the University of Alaska Learn Alaska Network, to transmit instructional programing for preschool through college level students; in addition there are courses in basic educational skills for adults. Satellite access to instructional programing libraries in other parts of the country is technically possible and is being investigated for its operational practicality.

Experience gained during the first few months of the television demonstration program showed extremly high interest for both entertainment and instructional programing, in rural and urban parts of Alaska. Additional funding for extending the program has been granted to enable the State to better provide means for including all communities and developing acceptable financing methods for continuing operation.

In addition to the small earth stations which are the primary subject of this discussion, the 30-meter station at Talkeetna and fifteen installations with 10-meter antennas are now in service. Approximately ten more 10-meter stations will be constructed to handle high-density commercial and military traffic. One hundred ten (110) small earth stations are currently in operation; this number could increase to 200 before all needs are met.

The small earth station program initially was hampered by serious reliability problems. The channel equipment manufacturer was plagued by solid state component failure, connector and cable failures. The traveling wave tube power supply transistors would short, damaging the expensive TW tube and other components. Coordinated efforts by the State, the common carrier and the manufacturers resulted in resolving the reliability problems in the equipment. Now the major problem affecting the earth station availability is the reliability of the village power systems.

Satellite communications is meeting needs in Alaska that would be prohibitively expensive by any other means at this time. In many respects a number of the larger developing nations have similar communications problems which can be most effectively solved through satellite telecommunications systems of this type. Advances in technology since the Alaska system was designed, especially in digital techniques, make it likely that other systems would differ in detailed parameters while still utilizing the concept of employing many small earth stations.

TELECONFERENCING

As the television demonstration program developed and other telecommunications facilities became available, several individuals and groups began looking at the possibility of using various forms of teleconferencing to cut down on the long distance one must travel to attend meetings. Juneau, the capital of Alaska, is almost 1500 miles from the northernmost part of the state and 2000 miles from the most western areas. This, and the fact that Juneau is not connected by road to the other parts of the state, has led to a feeling of isolation from the processes of government by the constituents. The voters of Alaska expressed their deep concern for this problem by signing an initiative petition and voting to move the capital from Juneau to a location between Anchorage and Fairbanks that is accessible to a far greater portion of the population. The legislature is acutely aware of the public concern over its inability to participate in the legislative process and in an effort to alleviate this feeling, has begun to disseminate information in several ways. In 1975 the Legislative Council created permanent legislative information offices in Anchorage, Fairbanks, and 10 other communities for the purpose of providing factual information relating to pending legislation to members of the public and press. The legislative information office set up teletypes, voice circuits and a CRT computer terminal connected with Juneau at each location. Teleconferencing is extensively used in Alaska to reduce travel and provide the opportunity for more people to participate in many different programs. The Legislature has made the most use of the system to take testimony, conduct public hearings, and informational conferences. The administration has conducted hearings for the Fish and Game Commission and other similar applications. The court system has taken official testimony from witnesses in courtroom trials by teleconference. The library association, the University and similar organizations make daily use of the teleconferencing

services.

LOOK TOWARD THE FUTURE

The decade of the eighties will be an exciting time in satellite communications. The companies that are presently engaged in providing service expect to greatly expand their capabilities and additional companies are planning to develop extensive satellite communication systems. Some estimates place the number of transponders required world wide by 1990 at nearly 1000 units. The capability of the geostationary satellite arc to sustain this number of transponders is unlikely. It is estimated that perhaps 300 or 400 transponders represents the capability in space in 1990. The most critical consideration at this time is the allocation of the geostationary arc space to the various companies competing for satellite locations.

Directly related to the problem of satellite arc location is the efficient use of the radio spectrum at those locations. There are presently satellites in orbit with 12 and 24 transponder capability; by the use of polarization diversity frequency reuse is accomplished on several of these satellites. Using this technique effectively doubles the capacity of the satellite and orbit location. Satellites using K-band, 12 and 14 GHz, can be interspersed or co-located with satellites using presently available 4 and 6 GHz systems. Additional experiments are being conducted using 20 and 30 GHz frequency bands which will greatly expand the capacity for communication channels. Some of the new satellite proposals indicate 12 transponders but they plan 72 MHz bandwidth for each transponder as compared to the 36 MHz bandwidth on existing transponders. As in most instances, necessity produces more efficient use of available limited resources and satellite telecommunications is no exception.

The State administration has consolidated its telecommunications programs under a deputy commissioner with directors of operation and planning. This coordinated approach to statewide planning and operations brings together a number of diverse programs under one agency. The Department of Education and the statewide University system through a consortium, also coordinate with the Division of Telecommunications for the most efficient and effective distribution of the available educational programs. It is anticipated that further deployment of basic telecommunications services to all Alaska and continued development of innovative new services will keep Alaska in the forefront of telecommunications technology.

CONCLUSIONS

Alaska telecommunications sytem has had tremendous growth in the past ten years providing improved communications and new innovative services which has resulted in a significant reduction in the feelings of isolation and separation from the mainstream of American life. The ability to get high quality, rapid telephone connections throughout Alaska and around the world contributes to the growing economy of Alaska. There is an equally dramatic growth potential in such areas as audio and video teleconferencing, digital communication, expanded use of telecommunication in classroom instruction, kindergarden through grade 12, at the University level and continuing education for all ages. The State has leased a second satellite transponder for educational instruction programming. FCC licensing of 150 more earth stations and mini-television transmitters are nearing completion with more than 80 sites having been installed this year.

A specialized common carrier license has been approved by the FCC (spring 1981) to encourage competition in communication services available in Alaska beginning with Anchorage, Fairbanks, and Juneau, and from Alaska to the world through a gateway earth station in Seattle, Washington.

It is expected that the existing 110 small earth stations owned by the State will be sold to local telephone companies or a common carrier in the near future.

There is still a long way to go before "universal telephone service" is available to all Alaskans. State and local governments, in cooperation with the telecommunication industry, must continue to work together to further improve the quality of communication services, particularly in the rural areas. The reliability of the equipment used needs further study and replacement of unreliable components. The installation of redundent subsystems in critical areas will greatly improve reliability. The development of a program to improve local power generation available in the smaller villages is essential to uninterrupted operation of the communication system. We look forward to continued involvement in developing improved telecommunication systems in Alaska and anticipate improved services, increased reliability and innovative programs being available in the near future.

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Military Long-Lines Communications In Alaska 1900 - 1976

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1. Abstract

This paper covers the history of Alaskan communications from 1900 through 1976. Included is a brief summary of the construction and operation of the first single line telegraph, and subsequent conversion to a tropospheric and microwave radio network. The system not only provides communications for the military, but also has been the primary carrier for commercial communications throughout the state.

2. INTRODUCTION

Providing communications for a growing Alaska is exciting and challenging. From the first single line telegraph installed in the early 1900s to modern satellites, the military communication system in Alaska has met the unique requirements and has overcome the harsh environment of the Arctic. Each phase of progress has been highlighted with many technical advances, significant innovative action, and not uncommon heroic adventures.

At the outset, it was realized that civilian communications requirements alone could not financially support a communications system in Alaska, and although the civilian demand has increased immensely over the years, it is still not economically feasible to provide separate facilities for military and civilian operations.

There are three characteristics which underlie most of the problems facing the development of communications in the 49th. state. While they are not necessarily unique, their magnitude makes them loom large in importance when considering the undertaking of any operation. The three characteristics are: the climate, transportation and the population density. The climate is extreme and dictates the type of activity which can be carried on in any given season of the year, and also dictates the type of communication systems which will be effective. The simple statement that the state is 1/5th the size of the contiguous 48 states (the "lower 48") doesn't truly point out the significance of its size and it completely ignores the shape which is all important to the supplier of communications. We begin to focus on the real crux of the problem and the cost of communications per capita when we realize that the population of Alaska is approximately 400,000; the same area served by telephone companies in the north central part of the lower 48 is roughly 84 million.

The important characteristic to realize is that the density of population in the lower 48 is about 20 people per square kilometer and the density in Alaska is about one person for every 9 square kilometers

In the era of terrestrial communications, particularily landline facilities, the density of the population was an extremely significant economic factor, however today, with satellite communications, the distance between population centers is of no consequence. It costs no more to provide communications by satellite between communities thousands of miles apart than it does between communities that are separated by only a few miles. Thus, the characteristics of Alaska that have worked against the development of adequate communication systems are now working in favor of Alaska being the forerunner in the effective use of state-of-the-art satellite communications. An important point to bear in mind is that because of the difficulty of providing communications by terrestrial means, the State of Alaska has lagged behind the lower 48 in the use of communications technology. Now this lag in technology will allow Alaska to abandon the outmoded system and advance directly into satellite communications without the serious economic impact of discarding a large investment in terrestrial facilities.

3. TELEGRAPH LINES COME TO ALASKA

In the 1850s, the first dream of a telegraph line in Alaska, then Russian-America, was formed in the mind of Perry McDonough Collins, an agent for a Siberian trading firm at the mouth of the Amur River. Collins had traveled from St. Petersburg, Russia, through Siberia, and then had followed the Amur River to the Pacific in 1856. At that time, he envisioned a telegraph line stretching from North America, across Alaska, and then to Europe along the path he had followed through Siberia along the Amur. (1)

Collins gained the support of an expansionist named William H. Seward for his idea. When attempts by others to lay a cable across the Atlantic Ocean in 1857 had failed, Collins and Seward secured the authorization of the United States through the Congress for aid to survey and construct the telegraph line.

The first action taken to construct the line was when Collins merged with Western Union in 1864 and formed the Collins Overland Line (2). This subsidiary of Western Union was created specifically to provide communications between the United States and Europe via the Bering Straits. In 1864 and 1865, the exploration and some construction of the Overland Telegraph Line began in earnest. Western Union began the scheme by completing one section of a line from San Francisco to Portland in 1864. The line was finally extended along the Frazer River in British Columbia behind the coast range to Ashcroft, B.C. at the headwaters of the Yukon River.

The military was involved in these early explorations. Robert Kennicott and six others, under command of Colonel Charles Buckley, surveyed portions of Russian-America in 1865 and 1866. In 1867, however, the news finally reached Russian-America that Cyrus W. Field had completed his trans-Atlantic cable July 27, 1866. All exploration and construction was discontinued when this word was received. (3).

The role of this early telegraph expedition in the acquisition of Alaska cannot be fully defined. There can be little doubt, however, that this early telegraph line contributed to the exploration for purchase of Alaska from Russia by the United States in 1867.

During the years from 1867 to 1900, development and exploration of Alaska continued mainly for minerals. The wealth of Alaska was just beginning to be realized as prospectors and trappers headed north for the riches that were to be found there.

The military has been continuously active in Alaska since the time of the purchase and has been important in the development of Alaska. One of the first policing actions performed by the military was the setting of the boundary along the Yukon and the subsequent expulsion of a Canadian trading company from Fort Yukon. (4). The U.S. Army Signal Corps stationed weather observers in Alaska but soon withdrew them when it became apparent that little use could be made of the data they acquired due to the length of time it took to transmit to Washington.

For ten years following the abandonment of the telegraph project, the affairs of the Alaska Territory were administered by the U.S. War Department with small Army garrisons maintained at selected points. The discovery of gold in the late 1890s brought thousands of prospectors stampeding to Alaska. In response to an immediate need to protect the prospectors in the newly established gold camps from Indians, and even from each other, military headquarters were established in Alaska at Fort St. Michael on Norton Sound. Other garrisons were established near Nome, near Tanana, at Eagle, near Valdez and at Haines Mission. As the number of garrisons and troops increased, the necessity for rapid communications between these garrisons and their headquarters in Washington became critical. It could take as long as one year to send and receive a message between interior Alaska and Washington, D.C. (5).

As a solution to this problem, the War Department proposed that communications be established to connect the various garrisons and that a territorial telegraph system be constructed in Alaska and extended to Seattle, where existing networks would be used to reach the War Department in Washington, D.C.

On May 26, 1900, Congress passed an act to establish the Washington-Alaska Military Cable And Telegraph System, or WAMCATS as it was known. This act expressly stated that the system would provide commercial service whenever this

function would not adversely affect military traffic. The WAMCATS system was completed by 1904.

The telegraph system placed into service in 1904 presented unique problems in construction. Much of the line was built through muskeg and swamp area that would not support a single pole. This was overcome, in the early days, through the use of tripods. Three long spruce poles would be cut, tied together at the top, and spread into place supporting the insulator and wire placed at the top of one pole.

In areas where there were no native poles to be found, the solution was found in installing iron poles made from pipe. Remnants of those lines can still be found in remote areas of Alaska around Nome and along the Taylor Highway towards Eagle. The line was a single copper wire, using ground return.

The cables installed in 1904 were single wire, rubber covered and American made. They were expected to last five years, but saw service until 1924 when they were replaced with English made gutta-percha covered cable.

The telegraph link between Fort St. Michael and Nome posed special difficulties since it had to cross Norton Sound. A submarine cable was laid across the sound from Fort St. Michael to Port Safety. Shifting of the winter ice pack however, continuously carried away portions of the cable until a 60 kilometer section of the cable was ripped out November 24, 1901. This failure led the U.S. Army Signal Corps to evaluate other methods of communication. Although wireless systems were just being developed, it appeared they might be the solution. No equipment was available that would transmit over 150 kilometers required by this link. In 1899, the Signal Corps had established the first regular wireless system in America over the 20 kilometers of water separating Fire Island and the Fire Island Light Ship off the coast of Long Island, New York. The Signal Corps had also established a wireless system extending little more than two kilometers in the San Francisco harbor.

The government awarded contracts to two private firms, Queen and Co. and Marconi Wireless Co., to provide a wireless circuit between the two forts. Both companies failed. Using its previous experience, the Army Signal Corps took over and developed the wireless system which opened August 17, 1903. The successful application of this wireless link in the WAMCATS system was the longest wireless section of any commercial telegraph system in the world. (6).

A description of this wireless equipment is quoted from a manuscript entitled, The Story of the Alaska Communication System (7). These early wireless stations (radio is a much later term) were the spark type. The sixty-cycle, 500-volt output of the alternator was stepped up in a heavy transformer to 20,000 volts. This high voltage charged a Leyden-jar condenser, which discharged across a spark-gap formed by two metal rods. The radio energy thus produced coursed through a massive coil called a helix, the terminals of which were connected to the aerial and a ground system of driven metal pipes. The crash of the spark could be heard a mile or more in the stillness of the Arctic night.

The sending key in those early installations was a heavy metal bar a foot and a half long to which was attached a hard rubber handle. After every six or eight messages, the operator was forced to shut down the transmitter and file the contacts, which were pitted by the arc that formed each time the key was opened.

The receiving equipment was of the most elementary DeForest type, modified by Signal Corps' invention. Tuning was accomplished by sliding contacts on coils of wire. The detecting device was a coherer of the Castelli type, consisting of a small glass tube in the center of which there was a bit of iron. Small globules of mercury were put in each end of the tube and pressed against the bit of iron by small carbon rods inserted in the ends of the glass tube. A telephone receiver was connected to the coherer as the device for reading messages.

Later, a crystal detector was substituted for the coherer with greatly improved results. The "cat's whisker" which rested against the crystal had to be shifted frequently, however, as the sensitive spot on which it rested quickly burned out from the energy of the received signals, or from the static of the aurora borealis.

It is believed that this was the first wireless telegraph system in the world that was regularly operated as part of a

telegraph system handling commercial messages. Certainly it was the first point-to-point wireless channel put in service on the American continent for commercial operations.

4. 1904 TO 1936

After the telegraph lines had been laid throughout the state in 1904 and the system was completed, a long period of consolidation and improvement commenced. The wireless system, having been proven across Norton Sound, was expanded to replace large sections of the open wire telegraph line where maintenance was a problem.

Submarine cables were placed from Seattle to Sitka and from Sitka to Valdez, creating an all American communications route from Alaska to the south. For the next twenty years, the system grew steadily. The commercial business of the system grew to the point that Congress provided authorization that forwarding charges due connecting commercial carriers would be collected and paid.

In 1936, Congress recognized the network as the Alaska Communications System, (ACS). The name was approved by the War Department as the official designation and was in general use until 1971 when the system was sold to RCA.

During this period, radio telephone began to replace the old radio telegraph system. The first radio telephone transmitters were placed at Marshall and St. Michael in the Fall of 1931. Juneau, Ketchikan, Fairbanks and Nome received their radio telephones in the following years. Bethel was added in 1934.

While the radio telephone system began to grow, the radio telegraph system was to shrink. Between November, 1933 and November, 1935; thirteen of these stations were to close. Despite low traffic volumn from many stations, no other closure was permitted until 1943, when Kanalcanak was taken off the air.

Some of the first transfers of the military radio equipment to commercial companies took place in this early period. In some instances, the equipment was sold to the community and, in others, to the Northern Commercial Company's store at that point.

By 1936, the system was handling traffic from 129 commercial radio stations. The territorial government operated stations at 11 sites. Traffic increased at nearly 10 percent a year during the early 30s.

5. 1937 TO 1946

The period from 1937 through 1946 was, at first, a period of improvement; and then, with the onslaught of World War, rapid expansion.

During 1937, there were a large number of daily periods when high frequency radio communications were interrupted by auroral disturbances. In the past, such outages had been minimized by the use of the old cable systems as backup. It was not the policy of the War Department to repair these cables as they failed and by 1937 most cable routes were no longer usable.

Medium frequency transmissions were not effected by aurora, so expansion and modernization of this equipment was undertaken. By 1938, it was possible to handle traffic from Seattle to most of Western Alaska with minimum outage time due to auroral disturbances through the use of short relays.

Expansion of the system to handle increased military traffic began in 1939. Direct teletypewriter and TWX service was inaugurated and a direct high speed radio channel was established to Washington D.C.

The garrisoning and fortification of Alaska in anticipation of war began during the summer of 1940. In 1940 there was one infantry post at the head of Lynn Canal at Haines. The Navy has only emergency stations and not a single Air Force plane nor a military airfield, was to be found in all of Alaska. Alaska was the site of the only armed invasion by foreign troops on the North American Continent during World War II. It was the Japanese attack on Dutch Harbor and their occupation of the Aleutian Islands of Attu and Kiska which convinced the War Department that immediate upgrading of Alaska's communications was necessary.

Communications were so poor during the early days of the war that the Japanese were able to bomb Dutch Harbor on the

island of Unalaska with unalerted American aircraft only forty miles away on Umnak Island. The noise of the attack and observation of the Japanese planes finally brought the American fighters into action, but not before Dutch Harbor was seriously damaged.

During the war, the ACS grew from a small organization of 200 men in 1940 to over 2,000 in 1944. Some of the line building accomplishments were as heroic during the war as they had been during the initial efforts of establishing the telegraph line in the early 1900s.

One of the first steps in upgrading the system was the rehabilitation of the Seattle-Ketchikan-Seward submarine cable. This effort began in October, 1941 and the Seward-Ketchikan leg was operational by November 15, 1941. By December 3, 1941 the cable was operational from Seattle to Seward. The cable had been designed as a simple system and one of the first priorities was to convert it to duplex operation. After many difficulties, the duplex circuit was placed into operation on July 16, 1942.

Planning and construction of a secure means of voice transmission became of highest importance to the Alaska military. The radio, while its reliability had increased, was not a secure means of passing military information. A new highway was being built through Canada to extend to Alaska. An open wire pole line designed for voice transmission was to be built parallel to the road. The open wire pole line was designed for Western Electric 'C' carrier capable of three miltiplex channels of voice per pair with repeater spacing of 100 miles (160 km). In August, 1942, the Miller Construction Company was given a letter of intent to construct such a line on a cost-plus-fixed fee contract. The line was to push 3,250 kilometers through untamed country. The complexities of the contract were more difficult to overcome in the first months than the construction itself. It was not until November 1, 1942 that things began to run smoothly.

A telephone call from Washington, D.C. on November 9, 1942 asked if it would be possible to have the first leg completed by December 1. The first leg ran from Edmonton to Dawson Creek, a distance of approximately 800 kilometers. There were several problems involved in the completion of this first leg. There were supposed to be four repeater stations along this route and they had not been started. Poles had been set along 600 kilometers of the route, but none of the pole line hardware had been delivered. A warm Chinook wind had blown for several days, taking out the ice bridges across the rivers. A snow storm leaving record amounts of snow followed the Chinook and drifts of 3 or more meters encountered.

By November 17, crews had been assembled from AT&T, Canadian Bell, and 144 men from the 843rd Signal Batallion.

On November 18, none of the 800 kilometers of wire had been strung and there remained but twelve days to complete the first leg.

Three ton trucks were driven over half frozen rivers where the ice would dip and sag. Men floundered through two meter snow drifts and strung wire by oil lamps, flash lights, and automobile headlights in temperatures of 30 degrees below zero. Daylight was less than eight hours and materials were hauled at night so that construction could be begun at daybreak. Crossing a river filled with drifting ice by ferry was another problem. The normal crossing time was one hour. This was shortened by tying messenger wire to the ferry at each end, and pulling it back and forth by trucks. The crossing time was cut to ten minutes.

Temporary buildings were constructed at the four repeater sites and Western Electric, Northern Electric of Canada and 843rd Batallion men installed the repeaters. In all, there were over 500 men who literally jammed the line through the teeth of the Canadian winter.

On December 1st, at 7:40 P.M., Washington, D.C. time, a call was received from Dawson Creek. The deadline had been met! the call was placed on an improvised line and the real line had still to be completed. It was January 30, 1943 before all the poles and wire had been strung and the line completed to specifications.

By May 22, 1943, the line had been completed to Whitehorse, a distance of 2,540 kilometers almost totally during the Canadian winter. The line still had to be completed between Whitehorse and Fairbanks, a distance of nearly 1,000 kilometers. Roads became impassable during the spring thaw. The line could

not wait for the road. The line work progressed rapidly through the long daylight of the summer but September still found 80 km of swamp to be crossed just east of the Canada/Alaska border. A twenty man detachment of the 255th Signal Construction Company was given the task of closing this gap by stringing twisted wire pair through the swamps.

Not since the early days of the telegraph line had such difficulties been faced. There were no roads and it was impossible to use heavy equipment, so the methods of the early 1900s were employed. Two Indian guides and twenty pack horses were obtained from the Trading Post at Burwash Landing. The coils of wire were loaded onto the pack train and the men packed into the bog.

The motto for the company was, "Through Muck and Mire We String Our Wire." They lived up to it. Pack horses bellied themselves in the muskeg and the men were constantly wet for four weeks at a time. The mosquitoes and white socks can only be imagined. Yet, by October 1, the first line was through and a talking circuit was established on a temporary basis from Fairbanks to Edmonton. The permanent line was completed on November 10, 1943. A telephone system that would have taken years to build in normal times was completed in fifteen months.

The installation of the pole lines and upgrading of the radio system ended the rapid expansion of the ACS. It was not until the postwar years that the next important changes to the system were to take place.

6. 1947 TO 1958

The next major changes to the system were due to commercial expansion of the territory during the postwar boom years. In 1952, a new open wire pole line transposed for Western Electric 'C' carrier was built between Anchorage Tok where it met an expanded system towards Fairbanks. Four pairs were equipped with 'J' carrier which now gave each pair the capacity to carry fifteen carrier voice channels plus a physical. The open wire system expanded the number of channels available to the border where it met the Canadian Line. To meet the expanded growth, a new submarine cable system was built from Skagway to Ketchikan by ACS where it met a new AT&T cable which extended from Port Angeles, Washington to Ketchikan. Each of these cables was carrier equipped and capable of 72 channels of voice using Western Electric 'L' carrier. To meet the demand between Skagway and Tok, the open wire systems were equipped with six channel multiplex carriers designed by Lynch.

Manual switchboards were placed into service to meet commercial needs at Glenallen, Tok and Delta Junction. These switchboards were replaced with new 100 line, 1000 CX North Electric all relay switches in 1958. By 1962, these telephone switches had been replaced by commercially owned switchboards.

At Fairbanks, Anchorage, Juneau and Ketchikan, new Western Electric, 3CL manual switchboards were installed to meet the traffic loads being imposed on the ACS. These were to be the last major expansions of the Alaska Communications System.

7. THE WHITE ALICE SYSTEM

The White Alice Communication System (WACS) came to life as a result of the Cold War. Attack through over the pole flights became a probability in case of war, and a distinct possibility during the Cold War.

As early as 1947, plans were begun in Alaska to defend against such attack. When it became apparent in 1954 that the military would be unable to design a communications system capable of meeting all the telecommunications needs of the Alaskan users, both military and commercial, the Air Force asked AT&T to do a study which would recommend a fixed multichannel communications system. The military had started designing a network of microwave and VHF radio systems that would cover Alaska. As soon as one problem would be overcome, another would crop up. The final blow was the interference between the VHF system and the radar that it was to serve. AT&T settled on a new technique called tropospheric scatter, coupled with microwave in the high density areas, as a solution to the communication problems inherent in Alaska. A series of Aircraft Control and Warning (ACW) sites had been built and the communications system known as White Alice was soon to follow.

The warning system was expanded to cover the very northern perimeter of Alaska and Canada and extended on to the ice-cap of Greenland. This system was to be called the Distant Early Warning (DEW) System. While not a part of White Alice, tropospheric scatter radio was used to provide communication to these sites as well.

In 1955, Western Electric received a letter contract to begin construction of the system. The original estimate to construct the system had been 39 million dollars. In 1958, at the conclusion of the first phase of construction of the White Alice, the cost of the network had risen to $113,230,000. Later in 1962, additions to the system would bring the total cost up to almost 300 million dollars. These expansions were into the Aleutian Chain extending to Shemya, and an extensive addition to the microwave system to the interior of Alaska and to the Alaska/Canada border near Tok. Another tropospheric scatter system was built through Southeastern Alaska to assure diverse routing of Ballistic Missile Early Warning (BMEWS) signals generated at Clear, Alaska.

8. ALASKA TELEPHONE SWITCHING SYSTEM

The number of Air Force installations that had dial PBXs or exchanges grew to about 50 during the early 1960s. These stations were all connected by an up-to-date long distance communications network. Major components of the network were the White Alice System, the DEW line, its Aleutian extension, and the BMEWS routes.

This network consisted of almost 12,000 kilometers of route and provided nearly a million kilometers of telephone circuits. The service between the installations was handled primarily on dedicated lines. This resulted in lines which were frequently not in use. As the requirement for additional communications increased, it became evident that relief was required. More circuits could be provided, a costly solution, or the existing facilities could be used more efficiently. During 1960, Air Force representatives suggested that a solution in terms of a long distance automatic switching system be used. Engineering studies confirmed that this approach constituted the most economical means of providing a substantial increase in service without requiring major additions to the existing radio systems. Thus, the Alaska Switching System was born. To facilitate a more appropriate acronym, the name was later changed to Alaska Telephone Switching System or ATSS as it is known.

A compact version of the Western Electric No. 4A Crossbar System was installed at four main switching centers. Cutover for the system was March 4, 1962. It is a four-wire, common-control crossbar system, capable of as many as six digit code translations, digit deletions and prefixing, code conversions and automatic alternate routing. Both one-way and two-way trunks utilizing all usual types of signalling could be handled by the system.

The four switching centers were chosen for installation in existing White Alice buildings at Neklasson Lake, Pedro Dome, Kalakaket Creek and Big Mountain. The Neklasson Lake switch serves the Anchorage-Elmendorf AFB complex and provides ready access to the commercial system. Pedro Dome serves the Fairbanks-Eielson AFB complex. Kalakaket Creek serves points out of the north westerly junction, and Big Mountain serves the points out of the south westerly route junction.

Since this system in Alaska carries much military command and control traffic, some calls must be placed without delay. Such an arrangement is included in this network, on a highly restricted basis, called the Preset Preemptory Priority (PPP). By pushing a button, the originator usurps trunks from the No. 4A machine user network, and will also usurp the local telephone circuit of the receiving party.

Each trunk group that traverses two or more major switching centers is assigned so that all the trunks are not the same circuit route. Diversification of route assignment provides for increased trunk group protection. The ATTSS also provides automatic alternate routing.

9. THE SALE OF THE ALASKA COMMUNICATION SYSTEM

Since 1904, when the telegraph line was completed, the military has tried to withdraw from its involvement in Alaska's commercial communications. Major General Greely wrote in his report to Congress in 1904 that the military should gradually withdraw in favor of private communications companies in Alaska. In 1913, General Scriven, then Chief Signal Officer, wrote that the military's

communications need was over in Alaska and tried, unsuccessfully, to turn the system over to the Post Office Department. That failing, he tried to convince Congress to turn the system over to the territorial government. That effort came to nothing, and it was not until 1967 that the military was to successfully convince Congress that the military communications system in Alaska should be disposed of.

Hearings before Congress resulted in the passage of Public Law 90-135, the Alaska Communications Disposal Act. Under this act, the military could dispose of any or all of its long line systems in Alaska.

The first system to go on the block was the Alaska Communications System. It was sold to RCA Alaska Communications (RCAA) on January 10, 1970. The sale to RCAA was the result of an extensive bidding process, in which four companies participated. RCAA spent 31 million dollars to purchase the system, promised to spend 27 million more in improvements and instituted rate reductions designed to save the Alaskan rate payer 40 million dollars during the sale contract period of three years.

What RCAA had purchased was the commercial outlets of the military system. Very little of the actual long line system was sold. None of the White Alice System components were involved in the purchase. However, the White Alice System was growing old and was unable to keep up with the ground demand for communication services in Alaska, which was caused by extensive oil discoveries on the north slope. In 1973, the Air Force presented a proposal to the state that would dispose of the system through lease or sale.

Finding that sale of teh WACS was not possible due to reaction of the state, the Air Force was successful in leasing the system to RCAA. The stipulations of the lease required RCAA to replace the tropospheric scatter portion of the White Alice System with its own network of satellite earth stations within 27 months commencing 1 July 1976. The TD2 portion of the system was sold to RCAA during this same period.

And so, the military has finally achieved it's goal, which started in 1904, of divesting itself of furnishing commercial communications in Alaska; thus, ending a period of 76 years of distinguished service to the state.

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The Evolution of the Present Alaska Telecommunications System

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Abstract

The Alaska telecommunications system has evolved from a primitive system, except for special military networks, to an almost totally satellite based system in the past decade. Most initiatives for improvement have come from the Alaska Legislature including the present major effort represented by the Learn/Alaska network.

The evolution of the present telecommunications system in use in Alaska began when the state began to make serious efforts to break away from the federally owned Alaska Communications System in the mid 1960s. Service to Alaska's residents had always been a very low ranking priority and most communications efforts were based upon military requirements. Occasionally, a spare circuit would be made available for civil needs. In rural Alaska there was no telephone service and none contemplated. Government radiophones were the only means of communication available, in the bush.

The sale of the above system to RCA in 1971 contained several conditions about increased service including one requiring service to 141 remote villages having no telephone service. By 1974, RCA had implemented service to only a few of these places and was proceeding slowly with expanding a microwave system. This system had major maintenance problems due to inaccessibility of repeater sites.

Meanwhile, Alaska had learned a great deal about satellite communications technology through the ATS-1 experiments and had pioneered in the use of small earth stations.

The proposed video experiments on ATS-1 were not possible due to early technical difficulties but in many ways this turned out to be a blessing in that the audio only programs demonstrated the delivery of both education and health services could be increased greatly in remote communities through reliable audio communications.

The ATS-6 experiments began in 1974 and proved that the small earth station technology could be utilized for video throughout Alaska. These two projects created a small group of people in Alaska who were experienced in the engineering and applications methodologies necessary to make satellite communications possible, useful and economically feasible in the tiny villages of rural Alaska.

RCA Alascom despite its difficulties in meeting its commitments and the political problems this was causing with the Alaska Legislature continued to place emphasis on microwave systems radiating from 10 meter earth stations.

In December 1974, the author was appointed Commissioner of Highways for Alaska and immediately asked the Governor to appoint him Chairman of a special working group on telecommunications. The Governor concurred and after preparatory meetings with Alaska Native leaders, business men and communications specialists, firm proposals were made to RCA Alascom to require them to change course and utilize the small earth station technology with their upcoming Satcom F2 satellite which was being prepared for launch at that time.

After two months of almost daily meetings, no agreement could be reached. It was proposed to the Alaska Legislature that the state design and purchase 100 small earth stations and the legislature concurred and appropriated $5,000,000 to do so. The state returned to the negotiating table with Alascom to work out ways of integrating the stations in the overall telecommunications system, especially the long distance telephone system, and agreement was reached in June 1975 for the state to own the stations and Alascom to operate and maintain them. Questions of ultimate ownership were deferred and have not yet been fully resolved.

A last minute change on the F2 satellite provided a canted beam which could be used with the small earth stations. At the same time, the state began actions before the FCC to force separation between Alascom and Satcom to insure that transponders would be secured under the FCC's "open skies" policy.

Alascom abandoned its microwave expansion and the small earth stations became the primary telecommunications system for rural Alaska. Only those parts of the state already having service remained on terrestrial systems.

The FCC proved responsive to the State's position. Several commissioners and senior staff had been familiar with the Alaska situation because of their involvement with the sale of the Alaska Communications System to RCA and this background tended to create an atmosphere of knowledgeable sensitivity to the situation in rural Alaska. Also, because of the ATS experiments Alaskan administrators and others involved in those experiments had been in Washington with some frequency and generated support for the rural telecommunications effort at PBS, HEW and in the then White House Office of Telecommunications Policy. The state was lucky to secure the services of expert counsel, Mr. Jack Pettit of Hanel, Park, McCabe and Saunders to pursue the policy issues of "open skies" leasing policy for Alaskan transponders firstly and through the years other policies as the debate over telecommunications deregulation continued to expand.

The Alaska Governor's Office of Telecommunications was especially staffed with personnel knowledgeable in these matters under Mr. Robert Walp in the spring of 1975. This group worked with RCA Alascom in developing the specifications and procedures governing the first generation of small earth stations.

In 1976, with small earth station installation underway the legislature decided that it was time to bring television to rural Alaska. Monies were appropriated for a TV demonstration to 21 villages and every year since villages have been added until almost all the state now received the one TV channel. Agreements were worked out with commercial broadcasters to provide programming free in exchange for free use to the transponder to bring real time TV to urban areas.

The next step was also taken at legislative initiative in 1979 when the Department of Education and the University of Alaska were asked to provide an assessment of the feasibility of statewide telecommunications instruction. The assessment reported back that it was feasible and desirable and the Learn/Alaska network development began.

This network involves video, audio conferencing and computer networks in an integrated delivery system for educational services throughout Alaska. Presently, over 100 sites are installed with one or all of the three above networks and the rest of the system has been funded for the rural areas. Urban delivery is awaiting installation of cable systems to service the major urban areas of Anchorage and Fairbanks.

As is clear from the above short recital, with a few exceptions, such as the small earth station initiative in 1974 and 1975, most of the pressure for rapid upgrading of the telecommunications system in Alaska has come from the legislature. The state administrations have never been comfortable with a strong telecommunications presence and neither have they encouraged an aggressive regulatory posture from the Alaska Public Utilities Commission (APUC).

The present system has evolved about as far as it can go using the small earth stations developed in 1975. There is no state telecommunications plan that is agreed upon by the administration, the APUC and the industry. Neither is there any state presence in the planning for the 30/20Ghz satellites that can be discerned at this time.

The reason for this is that the Governor abolished the state Office of Telecommunications in 1979 and did not reinstitute it until 1981. Thus there was no state planning presence for two critical years except for the Learn/Alaska network development which was restricted to instructional matters. Now with a new office established in the Department of Administration, the focus for telecommunications planning has been established again and, hopefully, the state will proceed with the vigor and imagination that it did in 1975.

Telecommunications in Alaska: A Progress Report

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In July of 1981 an executive order by the Governor of Alaska established new telecommunications responsibility within the State's Department of Administration. This was due to a need for centralizing and reorganizing the fragmented telecommunications operations that existed throughout the state. The order also addressed need for a research and planning unit that could keep abreast of the rapid advances in technology and provide planning and policy recommendations to other state agencies, the Governor and the Legislature.

HISTORY IN BRIEF

The past ten years or so have been remarkable in terms of telecommunications progress for Alaska. Considering that Alaska has only been in existence as one of the United States since 1959, and that few Alaskan communities had telephone service until as recently as 1970, there has been considerable progress to date. Alaska is a huge state, with a population of only about 450,000. Telecommunications links in Alaska probably play a more vital role in bringing people together than in any other state in the nation. Because of this, reliable and comprehensive communications is obviously a necessity.

Obtaining and maintaining reliable statewide communications has not been simple. Various factors have made this a complex task; for example, few interconnecting highways, extreme weather conditions, only three major urban centers and unreliable or unavailable electric power, as well as great expense to ship materials from "the lower 48" and the high cost to install facilities. The fact that Alaska is a state of many cultures and languages also complicates the process of trying to provide adequate telecommunications to all people. With these facts in mind, one can understand why the establishment of telecommunications in Alaska has an interesting history.

Prior to 1971, long-distance telephone facilities were operated by the Alaska Communications System (ACS), which was part of the U. S. Air Force. RCA Alascom purchased the system from the military in 1971, thus beginning their service as the only long-lines utility in the State.

In 1974, the Governor established the Office of Telecommunications (OT), which helped to promote the legislation in 1975 that provided five million dollars for the construction of small satellite earth stations in 100 Alaskan villages. These installations have since been completed, thus giving each village one telephone plus a push-to-talk voice circuit in the health care facility. Also, the Governor's Office of Telecommunications, in conjunction with other State agencies, created the Television Demonstration Project (TVDP) which provided one channel of entertainment, educational (programmed by the Department of Education) and public service television to those rural villages. The TVDP originally served 23 villages, but the project has been expanded to include 90 villages. Ultimately, due to legislative action in 1981, 200 rural communities will be included.

The State and RCA became partners in the earth station project, with RCA handling installation, operation and maintenance, while the State purchased the equipment. All this was the result of growing interest and belief that satellite technology was the best answer for Alaska's future.

During this time, the State's Division of Communications, (DivCom) which began in the Department of Public Works, was in operation as well. This group primarily installed and maintained radio equipment for the State Police, Highways Department, ferry system and the Fish and Game Department, as well as others. These communications responsibilities have grown along with the state and with advances in technology.

Aside from the TVDP project and these DivCom activities, other telecommunications-related services in Alaska included commercial and public broadcasting. However, television broadcast stations were primarily in large cities and served only urban audiences.

The Governor's Office of Telecommunications was disbanded in 1979, and in the same year the Division of Communications became part of the newly-formed Department of Transportation and Public Facilities (DOTPF). DivCom was the only formal telecommunications division in state government and was swamped with operational responsibilities from Barrow to Ketchikan. The Governor's Division of Policy Development and Planning and the Juneau-based DOTPF people did attempt to continue with OT's planning efforts, however.

Separate from these activities in the executive branch of State government and RCA Alascom's long-lines operation, the Legislature funded its own telecommunications project, which began in 1977. Legislative mandate established a task force to study, design and implement a teleconference system, to be used by the Legislature as a method to more closely involve Alaskans in the legislative process. The result was a dedicated, 4-wire telephone line that interconnected 6 Alaskan cities: Juneau, (the Capital), Anchorage, Fairbanks, Bethel, Nome and Ketchikan. This system is a private-line leased from Alascom and operational 24 hours a day. The system has since grown to reach 18 Alaskan communities and Washington D.C. and is today a constantly-used and extremely effective working tool of the Legislature. To date, it is the only legislative network in the country, even though teleconferencing itself has become very popular with other government bodies and corporate businesses in lieu of time and high costs of travel.

When not used by the Legislature or its administrative agencies, the Legislative Teleconference Network is available on a priority basis to other state agencies and non-profit organizations, for a minimal fee. It is used quite regularly by the Legislature, particularly during its approximate five month session. The Executive branch is considering the possibility of some form of teleconference system of its own.

All this brief, and incomplete, historical overview points to the fact that in recent years it has become apparent that the State of Alaska needs to pull together its telecommunications activity into a more effective organization. The lack of a viable planning function has become particularly troublesome.

EXECUTIVE ORDER 50

As a result, the Governor issued Executive Order 50, which became law on July 1, 1981. This reorganized the fragmented telecommunications structure under one umbrella within the Department of Administration. In the order, the Governor noted that adequate telecommunications facilities and services are essential to the conduct of government, commerce and private life, and "that these facilities and services should be available, to the extent possible, to all agencies and cities of the State regardless of location." Accentuated throughout the order is the need to minimize "the size and influence of government" and give consideration to the growth and development of the private sector.

THE NEW ORGANIZATION

The Governor stated that the goals cited in EO 50 could best be accomplished by consolidating all telecommunications activities in one Department. Thus, the Department of Administration gained a new Deputy Commissioner who now oversees two divisions; one, "DivCom", is now called the Division of Telecommunications Systems. This division remains much the same, headquartered in Anchorage and operating statewide with a complement of about 55 technicians and engineers designing, installing and maintaining state-owned systems and equipment, from VHF radios to small earth stations. New is the Division of Telecommunications Services, which is the planning and policy group. It had become apparent that with technology moving at such a rapid pace, and the continued funding and implementation of services such as educational television in the state, some in-depth research and expert planning should be taking place. Therefore, it is now the responsibility of this division to provide technical consultation, coordination and support to both state agencies and other public organizations.

Along with the two telecommunications divisions, the Department of Administration now also houses the Alaska Public Broadcasting Commission (APBC). The APBC was formerly in the Department of Education, and was originally known as the Alaska Educational Broadcast Commission. The Commission staff is headed by an Executive Director who helps guide the nine-member citizen group in its task to "encourage and supervise the development of an integrated public broadcasting system for the State and for the coordination of all public broadcasting stations." Its primary purpose is to support noncommercial public broadcasting "through the provision of operating and capital grants in support of the delivery of noncommercial programs intended for a general audience by locally controlled non-profit broadcast stations or telecommunications entities", as well as supporting "entities which also engage in the delivery of instructiona. for-credit programs."

SPECIFIC RESPONSIBILITIES

The Division of Telecommunications Systems is involved in a great number of new and continuing projects, many of them the result of appropriations by the Legislature. Among the Division's responsibilities, these are primary:

- Design, install & maintain telecommunications systems for State agencies
- coordinate with State agencies in performing their data and word processing tasks
- within the limits of available financing, administer and operate the TVDP
- be available to develop internal telecommunications systems, whenever feasible, for other State agencies.

Neither the Systems Division nor the Services Division may engage in any activity which

interferes with programming rights relating to commercial television, nor may they influence TVDP programming. However, the Systems Division does administer the Tape Delay Center for the TVDP, and supports the Rural Television Network (RATNET), a representative user group which is responsible for TVDP programming and scheduling.

Specifically, here are some of the major projects (and associated approximate funding) administered by the Systems group:

1) Expansion and improvement of Anchorage Trooper Dispatch Center (approx. $400,000)

2) VHF Radio upgrades from Anchorage to Glenallen ($300,000)

3) Navigational aids program, i.e. non-directional beacons for rural airports (2.3 million)

4) Remote weather report system (1 million)

5) Microwave installation in Anchorage area for traffic signal control ($100,000)

6) 4 Channel video microwave system for the Kenai Peninsula (1 million)

7) Extension of T.V. facilities from Anchorage to nearby community of Girdwood ($350,000)

8) Continued installation of television facilities in bush communities as a result of HB 165 (6 million and HB 50 (9 million).

Along with the major projects just mentioned, the Systems people are also involved in upgrading data transmission equipment for the Marine Highway System (ferries), installing a T.V. translator to Eagle River (outside Anchorage), improving emergency services by upgrading VHF radio coverage in the Kenai-Soldotna area and installing a backbone microwave system for radio and emergency telephone along the North Haul Road.

The new Services Division also has major responsibilities outlined in the executive order. Primarily, the services group will provide:

- technical consultation to educational and public telecommunications users;

- assistance where telecommunications services will be used for instruction, in the area of grant applications and development, to public school districts, the Department of Education, the University of Alaska and other State agencies as approved by the Deputy Commissioner;

- planning support for health and safety-related functions;

- assistance to the APBC

- a statewide comprehensive telecommunications development plan;

- reports to the Governor and Legislature on instructional telecommunications activities and a development plan for teleconference facilities and service.

In regard to the aforementioned basic duties, a number of projects have already begun in the Services Division. Present major planning efforts are:

1) Study on alternatives to State subsidization of T.V.

2) Telephone procurement plan for State agencies (as a result of deregulation and increased competition in the telephone terminal equipment market).

3) Coordination assistance during installation of new 2200-line all Centrex switch for State offices in Juneau (cut-over date December 5, 1981)

4) Assistance to Department of Health & Social Services in various Emergency Medical Services projects

5) Feasibility study for an executive branch teleconference system.

6) Long-range telecommunications development plan

ALASKA'S FUTURE

With the telecommunications reorganization in state government, the future looks promising for the State to "get ahead of the curve" by providing advance planning and well-researched policy recommendations to the Governor and the Legislature. There are many possible scenarios that can be envisioned for Alaska's future, provided the trend to keep pace with technology continues, as well as support and interest from both the executive and legislative branches.

Direct Broadcast Satellite service could be here within five years or so. The State may restructure the TVDP or turn over to private enterprise. In addition, data communications and teleconferencing may be interconnected sufficiently throughout the state in the near future, to pull together, even more than now, the far-flung population of Alaska.

Telecommunications is fast becoming a major force in Alaska and could become a factor in the State's Capital-move issue. The extensive

use of telecommunications could eventually make the geographic location of the Capital immaterial. Whatever the future holds, it is already evident that telecommunications is no longer a word spoken only by those involved in technology.

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System, Components and Techniques

Alaska and Alascom:
A Decade of Telecommunication Development

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ABSTRACT

Prior to 1971 public telecommunications in Alaska was provided via excess capacity in a military system designed primarily for defense requirements. This paper presents an overview of a decade of Alaskan telecommunication development, by a privately-owned corporation, in a diverse and challenging environment.

I. INTRODUCTION

An American author, Joe McGinniss, travelled extensively in Alaska in 1980. When he decided to set out his experiences in a non-fiction novel, he chose to title his work Going to Extremes. The word "extremes" is a particularly apropos description of virtually every facet - geographic, climatic, economic, and social - of the State and people of Alaska. It is, at once, the northernmost, westernmost and easternmost state of the United States. It is the largest in size, being more than twice as big as the next largest state, Texas. It has the lowest population density of any state, a mere .7 persons per square mile. It contains within its boundaries three distinct mountain ranges, including the highest peak on the North American continent. Seasonal temperature variation for the interior of the State can typically amount to 160° Farenheit, from 90° above in the summer to 70° below in the winter. It has the fewest miles of paved highway in the United States. At Barrow, there is no night for 84 days during the summer; during 67 "days" of the winter, there is no day. On any statistically derived bell-shaped curve, one will invariably find Alaska, not in the median bounds, but at one extreme or the other.

The provision of telecommunications services to such a land is, like that land, a unique story, one that is largely synonymous with the history of Alascom, Inc., the state's long-lines carrier. Alascom today operates a system composed of 158 earth stations of multiple sizes and capabilities located throughout the State, which interconnect the national and international toll telephone network to every village of twenty-five or more residents in the State. This system provides or is capable of providing voice and data services to all these locations by virtue of an unparalleled use of satellite technology. Seventy percent of all basic telecommunications services provided by Alascom in and to the State are carried by satellite, at a level of technical proficiency meeting or exceeding Bell system standards for public switched voice networks. Two channels of television -- one entertainment, the other instructional -- are provided to 110 remote villages via Alascom facilities. Dual channel video per transponder is used for urban network video distribution and video conferencing. Advanced private line networks are becoming a part of Alascom's way of life. A Time Division Multiple Access (TDMA) System will link a major oil company's facilities in Alaska with several locations in the "Lower 48". Packet and circuit switched data networks are being implemented and electronic mail distribution, using deployed printer concepts, is expected to be in service this year.

Growth in services and volume has been such as to warrant, and Alascom has recently proposed to the Federal Communications Commission, ownership of a complete satellite, devoted to meeting the requirements of Alascom's customers.

Virtually none of these services or facilities existed a mere ten years ago when, on January 10, 1971, Alascom commenced the private operation of long-lines telecommunications in the State.

The development of this system and of the services provided over it presents a textbook study of how a non-governmental, privately-owned corporation can adapt and apply scientific advances to the business and economic development of basic telecommunications services, even under the most extreme circumstances.

II. ALASKA TELECOMMUNICATIONS IN THE 60's: STARTING FROM SCRATCH.

Alaska in the 1960's was, as the State's motto recited, truly "the last frontier". The political growth of the state had been slow; although ceded by Russia in 1867, Alaska did not become a state until 1959, the next to last state (before Hawaii) to be admitted. Its economic condition, particularly in the remote or "bush" areas, was on a par with its political development. As one report noted:

> By almost every definition in the language of international economics, rural Alaska is an undeveloped area, and were it not part of the United

States, it could qualify for assistance from the World Bank or our own Agency for International Development. Abrams, Charles, Housing the Alaska Native, Anchorage (February 1967) (Alaska State Housing Authority Remote Housing Report No. 1).

Telecommunications were, likewise, in an underdeveloped state. Indeed, they might have been non-existent, but for the military requirements occasioned by the strategic position Alaska occupied in the 1950's and early 1960's. The geographic proximity of Alaska to the Soviet Union over polar routes offered the potential for advance warning of hostile acts, occasioning the construction of such military shields as the Ballistic Missile Early Warning System and Distant Early Warning lines. An integral part of that early warning system and the general military presence in Alaska was the requirement for communications between Alaska and the Lower 48 states. This need was addressed in part by the Alaska Communications System (ACS), a system composed of microwave and cable links constructed and controlled by the U.S. Air Force. In the course of developing and operating the ACS over this early period, the government undertook to make available to the civilian populace of Alaska excess or redundant capacity on its long-lines systems when not required to meet then-present military requirements. The high cost of construction and operation of an equivalent civilian long-lines system, coupled with the low population density (i.e., small potential customer market) provided no incentive for private enterprise entry into the State market for such services. Thus in the 1960's, basic commercial long-lines communications services - message toll and private line - were incidental to and, necessarily, afterthoughts of the government-owned and operated system.

The technology of the ACS reflected the military origins of the system and the proven engineering practices at the time of construction. Cable or line-of-sight microwave links connected the major population centers of Anchorage and Fairbanks to an extended terrestrial system leased from Canadian companies between the borders of Alaska and the border of Montana. Civilian communications, when permitted on the system, were back hauled to Seattle for switching into the domestic toll network by the American Telephone and Telegraph Company. Where costs of microwave or cable construction, because of terrain and climate, exceeded even the government's financial resources, supplementary systems, such as the White Alice Communications System (WACS) existed to connect specific locations of consequence to the armed forces located elsewhere in the State. The technology employed most frequently was that of tropospheric scatter propagation, a technology developed in the early 1950's and of substantial limitations in terms of its reliability and quality. Locations not in themselves significant in the military scheme of things or not on the telecommunications path to and from militarily significant points received, by and large, no service at all, except as might be available from individually owned, high frequency radios. The most basic of basic services, such as direct distance dialing (DDD), inaugurated in the Lower 48 in the early 1950's, was unavailable to anyone in Alaska in 1971.

The Alaskan populace, though small, proved vocal on the subject of unsatisfactory telecommunications service. Political pressure developed in the 1960's favoring the transfer and operation of the ACS Commercial System into private, non-governmental hands, where civilian requirements would cease being secondary to military ones. In 1968, federal legislation passed which authorized the sale of the ACS by competitive bid to interested private parties. Unlike typical government competitive bids, however, the competition for the ACS focused not upon price, which was essentially fixed, but upon the range of service improvements and offerings and rate reductions proposed by the bidder. Alascom's first parent company, RCA Global Communications, won the competition; following the negotiation and execution of a contract of sale, ownership and operational control of the ACS passed to Alascom in January, 1971, for the sum of approximately $32 million.

It is worth noting, from the perspective of the closing decade of the 1960's, the modest expectations which the interested parties to the ACS sale held for Alaskan telecommunications and, by inference, for Alaska itself. Alascom had contractually committed itself to the following undertakings:

> Provide basic service to 142 remote or "bush" locations
>
> Explore the feasibility of providing satellite service for up to 49 locations in Alaska
>
> Spend slightly more than $28 million on future capital investment for telecommunications development in Alaska.

Service via satellite was an experimental concept to be explored for possible use in a relatively few locations. Service to the majority of locations would rely principally on microwave, possibly in conjunction with some satellite technology, the whole likely to require less than an additional $30 million.

For the Alaska of 1968, with a population of 280,000 and 82,000 telephones, it might have been enough. Against such a modest historical backdrop, modest expectations were appropriate. History, however, does not always repeat itself, and the Alaska of the 1970's was to bear no relation to that of the 1960's.

III. ALASKAN TELECOMMUNICATIONS IN THE 70'S: OVERTAKING THE FUTURE.

In 1971 Alascom inherited a telecommunication system which, by any objective standard, lagged two decades behind contemporaneous systems in the rest of the nation. This condition found reflection in the contractual provisions of the ACS sale and of ancillary agreements for other segments of the military system, which provisions obligated the Company not merely to expand, but in many circumstances, to retire existing system components and replace them with altogether new equipment and system designs. For Alascom, the initial goal of the early 1970's was to try to bring Alaska's basic telecommunications to a state of parity, in technology and quality of service, with those generally prevalent elsewhere in the country at the close of the 1960's.

Toward that end, Alascom embarked upon a major construction program designed to meet those standards. Major reorganization to the switching network was undertaken. Class IV switches were added to Anchorage, Fairbanks, and Juneau toll centers. Stored programming technology was installed to bring DDD to Anchorage in 1972 and the rest of Alaska in 1975.

The course of these changes, however, was itself to be changed by events occuring at both the state and federal level with direct consequences for the social, political, and economic structure of the State. Large oil reserves at Prudhoe Bay on the North Slope of Alaska were confirmed in 1968 and rights thereto were auctioned off by the State in 1969 for the then unprecedented sum of $900 million. In 1973, Congressional approval was received for construction of the TransAlaska Pipeline System, one of the preeminent technological marvels of this century. The economic ripple effect of the oil discoveries and pipeline construction stimulated business activity to unforeseen levels; the job opportunities created thereby caused dramatic increases in the relatively small population base. These new businesses and their new resident employees, created substantially increased demands for and burdens upon the telecommunications networks in Alaska.

Moreover, the pipeline itself required multiple innovative communications systems. A Blockvalve (BVS) or Remote Gatevalve System (RGVS) was required to continuously monitor the line and to permit instantaneous closure of the pipeline at one or all of 63 points along the line, to minimize the danger of oil spillage upon the fragile tundra. A Backbone Communications System (BCS) was developed to provide end-to-end microwave channels upon which carriage of both pipeline company and general public message communications could occur, to or from any site upon the line. As a further protective system, four earth stations were placed at strategic points along the line to create a satellite-based Alternate Route Communications System (ARCS) which served as an alternative system to the terrestrial microwave system of the BCS. Each system required capital resources and engineering skills of Alascom over and above those foreseen at the beginning of the decade, in addition to those required for the simultaneous upgrading and expansion of the intra and interstate message network which had been the first task at hand.

Of equivalent impact to the pipeline was the social reassertion and involvement of the native peoples of Alaska. After years of effort, native Alaskans secured passage in Congress of the Alaska Native Claims Settlement Act. This Act created twelve native corporations in Alaska and granted to them, collectively and sequentially, sums amounting to almost $1 billion and land totalling 44 million acres. No longer relegated to political and economic, as well as geographic isolation, Alaskan natives found themselves shareholders in major corporations with multimillion dollar economic potential in the form of cash and natural resource holdings. As they joined a mainstream of Alaska life beginning to accelerate as a result of oil development, their demands for telecommunications services grew in response to the growth of their economic and political involvement in the State. These demands, like those of the pipeline and its related activity, required further commitments of capital and human resources in support of telecommunications activity beyond those foreseen at the end of the earlier decade.

On the federal level, equally significant events transpired. In 1972, the FCC concluded, in Docket 16495, that the age of commercial domestic satellite facilities had arrived and began to issue authorizations to qualified applicants. Alascom, as a subsidiary company in the RCA domestic satellite effort, was part of the first operational domestic satellite facility in the United States, commencing service to Alaska over the Anik II satellite in 1973. In 1975, RCA launched Satcom I; in 1976, Satcom II. The availability of transponder capacity and the reliability and capability of that capacity, opened new potentials for service, particularly in those areas of the country where terrain and climatic extremes made ordinary wire and microwave systems economically impracticable -- in other words, in areas such as bush Alaska. The original ACS purchase contemplated feasibility studies for satellite service to less than 50 sites in the State. Increasingly, satellite service to virtually all points in the State became a feasible concept.

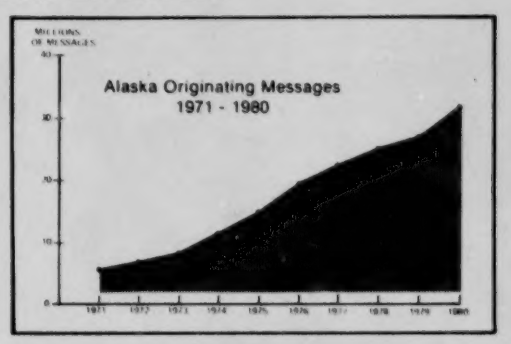
It would be pleasant to record that these disparate forces, far exceeding in scope and degree any extrapolation from the prior decade, and embodying disparate telecommunications requirements and goals, conjoined in a naturally harmonious whole. They did not. Alascom's initial proposals for service to the bush areas met resistance from the State of Alaska. Reflecting,

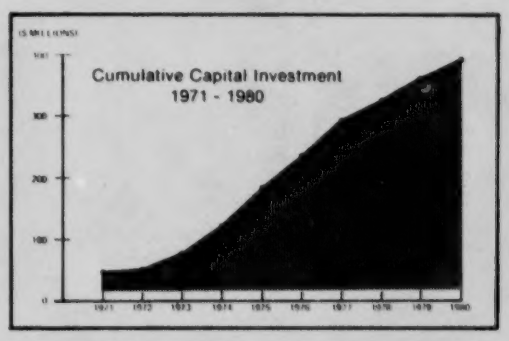
perhaps, the effects of the growing political force of those regions, and perceiving the first flow of tax and royalty revenues from the oil wealth that was, in 1981, to bring approximately $4 billion into its coffers, the State sought more extended use and extensive reliance upon satellite facilities, in configurations different from those proposed by Alascom. The State went so far as to procure pieces of some earth station facilities, and to seek FCC authorizations to operate the network itself. A compromise was reached in 1975 which permitted Alascom to build and operate 100 small earth stations throughout Alaska in trust, pending FCC license approval. Subsequently, the State withdrew its applications from before the FCC. The compromise, however, compelled the field installation of prototype SCPC equipment, often in villages with no regular source of electrical power. Initial development, maintenance and operational costs were thus increased, even over the increased amounts occasioned by the expanded use of satellite facilities themselves. Other policies set the Company and the State on different tracks. The State argued to the FCC, for example, that Alascom should never own, but should only lease transponder capacity on a short-term cancellation basis. Alascom sought, and obtained, approval for more secure arrangements. To anyone familiar with the recent and extensive litigation surrounding the Satcom III transponder shortage in 1980, the wisdom of the latter course is apparent; but the circumstances of 1980, in such a rapidly changing field as telecommunications, were as difficult to foresee in 1975, as those of 1975 had been in 1970.

Other challenges to the provision of telecommunications abounded. A new microwave system linking major communities in Southeastern Alaska was constructed and placed into service in 1975, finally retiring tropospheric scatter facilities incapable of meeting the service demands presented. Major earth stations were constructed throughout Alaska to replace other antiquated tropospheric scatter facilities of the WACS. Gateway earth stations were constructed in Juneau and Anchorage, Alaska, to attend to increased traffic demands and to secure the protective alternate route and redundancy needs of a system increasingly dependent upon satellite communications for the majority of its traffic. In conjunction with the State of Alaska, a statewide television network began, with real-time and tape-delayed broadcasts being beamed to villages throughout the State.

The technical demands upon Alascom in creating the major portions of Alaska's telecommunications network entailed concomitant economic requirements, as well. The original commitment of $28 million in capital expenditures, substantial by 1970 standards, was, by 1976, understated by an order of 10 magnitude. By the end of its first decade of operations, Alascom had invested over $400 million capital dollars in meeting the telecommunications needs of the State. The recovery of operating revenues from rates and intercarrier revenue pools -- a prosaic matter for Lower 48 telephone companies in the 1970's -- was a novel issue in Alaska. The Ozark Separations Manual, for example, was not adopted in Alaska by the Alaska Public Utilities Commission until 1976. It was not applied by the FCC to Alascom's interstate operations until 1981. In the interval, extensive negotiations, regulatory proceedings, and judicial activity were required by Alascom to establish the basic framework for rate and revenue development and to secure its present economic stability.

A statistical stillframe of Alascom today suggests the substantial degree to which the telecommunications challenges of the past decade in Alaska have been met.





Alaska telecommunications have progressed from obsolescence to the forefront of applied state-of-the-art techonology and for the moment, it might appear that Alaska has overcome its past and overtaken the future in telecommunications. The end, however, is not yet in sight.

IV. ALASKAN TELECOMMUNICATIONS IN THE 80'S: CHANGE AS A CONSTANT.

As they have in the past, changes in the nature and the direction of Alaskan telecommunications are likely, and are likely to proceed from two principal sources.

The first will be those factors indigenous to the telecommunications industry itself. As the 1980's open, our industry faces significant change as a result of regulatory and Congressional

activity, designed to apply to the telecommunications marketplace the precepts of competition. The manner of that application, as the multiplicity of FCC decisions, Congressional bills and amendments, and individual party position papers suggest, is not self-evident. Many questions remain to be answered, particularly those affecting the provision of basic telecommunications services to those in this country on the economic byways, rather than the economic highways, of telecommunication. Universal service, a goal elsewhere long since realized, is only now becoming in reality in Alaska. Alascom was originally authorized by the FCC and the APUC to operate initially as the sole long-lines carrier for Alaska precisely because of the economic imperatives flowing from unified service provisioning to a small, widely scattered population by means of a cost-effective, but not cost-free, modern technology. Questions concerning deaveraged rates, competitive pricing, and geographic market entry and withdrawal, therefore, are vital, not theoretical, matters to Alascom's customers in the bush, whose "product elasticity" choice is between a continuously available telephone and a once-a-week bush aircraft.

Percentage Of Main Stations Per Household

Continental U.S.	97%
Alaska	92%
Rural Alaska	13%

The second, and equally important source, will be changes in the State of Alaska itself. The effects of the oil development of the mid-1970's portend to remain with the State for the remainder of this decade, as oil related revenues continue to stimulate, directly and indirectly, the State's economy. The proposed natural gas pipeline through Alaska would enhance that circumstance. Alaska, moreover, may prove a significant future source of natural resources for the nation in many other materials. A 1980 report compiled by the Alaska Division of Geological and Geographic Surveys outlined the potential for developing more than 20 minerals in Alaska. These include four primary "strategic" minerals required by the United States and for which it is presently dependent upon foreign sources: cobalt, manganese, chromium, and platinum. Trial usage by foreign firms of Alaska's coal reserves, among the largest in the United States, has been planned. Alaska's timber and fisheries resources may also prove of increasing importance to the nation.

All these considerations suggest that as the 1980's proceed, the relative importance of and the activity relating to Alaska will increase. Change in the nature and intensity of this activity will bring concordant changes in the demands for telecommunications services. Underlying these changes will be structural modifications to the industry itself, brought about by the political, economic, and regulatory forces attending "competition" in telecommunications.

The prospects for Alaska telecommunications, thus, unlike Mr. McGinniss' novel, have no end, merely a constantly renewed beginning. Alascom, in a sense, has never enjoyed the relative luxury of any stasis since its beginnings a decade ago, and is thus uniquely positioned and adapted to face change, whether structural within the industry or arising from the character of the State of its incorporation. We look forward to that challenge.

The Alaska Small Earth Station Program: Mitigating Isolation through Technology

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1. Abstract

Intended as an economic method to quickly introduce reliable and high-quality communication into bush Alaska, this program, within the space of three years, transformed village communication from a system relying on hf radio or single line VHF telephones to one based on satellite technology and providing a full range of long distance telephone service as well as entertainment and educational television. Always at the leading-edge of technology, in 1975 the system pushed the state-of-the-art in earth station design in several ways. Later, the introduction of television required development of transmission parameters ideally suited to the best of the available receivers. Growth of rural communication demand has seen the introduction of local exchanges producing large volumes of toll traffic with regional communities of interest which will in the near future bring about the need to introduce even more technological solutions to prevent exhaustion or uneconomic use of satellite facilities.

2. 1975: THE CONVERGENCE OF NEED, MEANS, AND TECHNOLOGY

In the early 70's bush Alaska suffered the worst communication system in existence in the United States. Most villages had only an hf station for communication of messages of only the most urgent kind—when conditions permitted. A few, fortunate enough to be geographically close to larger towns with more extensive telephone systems, had a telephone linked by VHF radios which provided dial service, although in many cases villages competed with each other for a limited pool of available frequencies and suffered an extremely poor grade of service.

The need for modern communications had been felt for some time but was becoming acute. Commerce in the bush was rapidly increasing as the transition toward a money economy accelerated, driven in part by the Native Land Claims settlement and by resource development in oil and fisheries and the general upswing in the Alaska economy of the early 70's. Health care delivery required readily available and reliable communication between village paramedics and professionals in regional hospitals. Elected representatives and government officials needed a means to communicate with their constituents and the rural public. At a personal level communication among family members and friends, which was severly limited by the existing systems, took on new urgency as increased migration out to cities and jobs separated them.

At this time satellite communications earth stations had been installed in most major cities and larger towns with a statewide system covering these places to be completed by the end of 1976. Improved, although still somewhat less than optimum, satellite coverage of Alaska was to be provided by the Satcom I satellite owned by RCA Americom and scheduled for launch in late 1975. A satellite based solution to the problem of delivering more adequate communications to bush Alaska had been proposed using the proven technology of large (8 to 10 meter) earth stations with terrestrial delivery to individual villages clustered around the stations by VHF and microwave systems. This approach suffered from three major drawbacks: it was expensive, would take many years to complete and was limited in ultimate capacity by the end links to an unacceptable degree, particularly with respect to television delivery.

Competing with the proven technology of large earth stations was a proposed system which would employ antennas of only 4.5 meters in every community to be served. Such a system would be more economical than one based on a conventional approach because the stations themselves were cheaper to buy and install and no end links were required. Also their ultimate capacity was limited only by satellite capacity and to an amount far greater than projected demand. This proposal depended primarily on the recent or projected availability of three things: 1)a satellite with sufficient effective radiated power (EIRP) and sensitivity to work with the small antennas, 2)telephone channelizing equipment with performance and features not previously offered, and 3)a recently available low noise amplifier (LNA) using field effect transistors (FET's) which combined the desirable features of very low noise, low price and high reliability.

Ironically the choice between these approaches, each of which had its merits and advocates, was made not by technologists but by the Alaska legislature which provided the means to move ahead by appropriating the funds to purchase and install 100 small earth stations. They in effect opted for the solution employing advanced technology.

2.1 COMPONENTS OF A SYSTEM FOR BUSH ALASKA

Domestic satellites, designed with primarily the continental US in mind, provide inferior service in the high latitudes of Alaska because of

geographic separation. This results in a requirement for larger earth station antennas to compensate for the deficency of coverage. A portion of the Satcom I satellite was to be modified to improve its performance in Alaska. This would be accomplished by partially canting one of the four transmitting antennas toward Alaska, resulting in an approximate 60 percent increase in received power in Alaska for six of the satellites 24 transponders. In addition, the receive sensitivity of two transponders was to be increased by a factor of 2.5 allowing the use of comparably smaller transmitters at earth stations accessing those transponders. After the initial design of the small earth station network was finalized, the Satcom II satellite was modified further to provide near-optimum coverage by fully canting the equivalent transmit antenna which would raise the signal strength in Alaska to 2.5 times that of the original unmodified spacecraft. These changes to the satellite met the threshold requirement for a system employing small earth stations.

The single channel per carrier (SCPC) technology chosen for the telephone channelizing equipment was not entirely, new having already been used in the international communications satellite system (INTELSAT) and—to a limited degree—in domestic systems. The SCPC systems implemented to date, however, were unsuitable because they had not been designed with both economy and maximum performance as primary objectives. Nevertheless there were a few new designs targeted at domestic markets abroad, which had built on previous experience and offered price/performance combinations which were attractive. One of these systems, manufactured by California Microwave, Inc., was chosen for the bush system. In addition to low cost this equipment met the requirements for toll quality audio performance, fully synthesized channel frequency and fm threshold extension. The combination of these factors was considered necessary to allow respectively, integration into the national toll network, future improvement in transponder utilization efficiency through the introduction of demand assignment of channels, and operation near threshold as dictated by the earth station design. This equipment, which was expandable up to eight channels by the simple insertion of modules, was to be provided initially with two communication channels, a simplex push-to-talk channel for health delivery (a method prefered by the Native Health Service because of its success in expiremental use on the ATS-1 satellite), and a single telephone channel to provide long distance service.

Recent advances in FET design allowed the selection of a unit having a noise temperature of 190 Kelvins. Compared to then-available parametric amplifiers, these units (manufactured by Amplica, Inc.) cost about eighty percent less, were much more reliable and consumed considerably less power. Their noise performance was somewhat poorer than the paramps, but, together with the 4.5 meter Andrew, Inc. antennas they gave a system gain-to-temperature ratio (G/T) of approximately 20 dB/K. This performance level was considered adequate, since, in combination with the SCPC equipment, it results in the system nearly simultaneously reaching transponder power and bandwidth limits, which is the optimum condition.

Completing the basic package was a 40-Watt Travelling Wave Tube (TWT) amplifier from Hughes Aircraft.

Integration of the system components and installation in the bush villages was to be done by (then) RCA Alascom.

This set of components resulted in a system which can support approximately 550 simultaneous telephone conversations. Table 1 gives a typical link budget for the bush telephone channel.

2.2 THE BEGINNING OF THE END OF ISOLATION

During the winter of 1975 twenty of the stations were installed in remote villages, and service officially began in March of 1976. During the next two years the remainder of the planned 100 stations were put in place. In most villages the equipment, which amounted only to one cabinet for the SCPC and TWT, and another for the battery supply, was installed in already existing space in an effort to hold down costs. In a few locations shelters were brought in where no suitable space existed. Local power was used wherever possible with generators provided only as a last resort because of the difficulty of maintaining them.

During the first few years of operation, the system seemed to provide frustration as often as it did high quality service. This was due to poor service reliability, resulting from extensive outages, and an overall system availability of 60 percent or less at times. But service was being provided, When it worked, it was at a level of performance unheard of in bush Alaska. The reliability has slowly improved but still remains lower than rural networks in the continental US.

3. TELEVISION: CAUTIOUS OPTIMIZATION

The success of the small earth stations in providing telephone service set the stage for demands that television be added as a service to rural areas which received then virtually no television broadcasting. The state's Public Broadcasting Commission had been experimenting for several years with low-power TV transmitters (Mini-TV's) to provide service within villages, but programming was limited and was supplied on a delayed basis on video tape. The residents of the bush wanted an expanded program schedule with at least some shows presented on a near real-time basis, and their representatives saw the small earth stations as a logical way satisfy these wishes.

In the spring of 1976 the Alaska Legislature appropriated $1.5 million for a television demonstration project to include live delivery

via satellite to the state's urban and rural areas. In 1976 satellite TV transmission was commonplace between large (10 meter) earth stations but no operational systems were using 4.5 meter stations for reception of TV.

3.1 BUSH TELEVISION TRANSMISSION PARAMETERS

At about the same time that installation of the small earth stations began, preliminary work was started by Beakly, et al at RCA Labrotories which lead to the bush TV Parameters adopted in late 1976. This research focussed on methods of testing satellite TV receivers to determine the state-of-the-art in fm threshold performance, since calculations showed that operation would be in the threshold region of conventional receivers designed for use at large earth stations which have considerably higher carrier-to-noise ratios than the small earth stations.

A test which subjectively, but repeatably, determined the threshold of a receiver was developed. This test was applied in the labratory to all available receivers, while deviation of the RF carrier, IF filter bandwidth and carrier-to-noise ratio were individually varied. The tests were also performed both with and without an audio subcarrier. The compiled data were then compared with calculated carrier-to-noise ratios and a tentative set of parameters was selected (Table 2). In effect the maximum filter bandwidth which would give an IF C/N equal to the threshold of the best receiver tested, plus the desired system margin (99% availability), was first selected, Then the maximum fm deviation for that bandwidth which would not cause the receiver threshold to rise was chosen. It was decided that sufficient unknowns existed that the approximately 0.5 dB increase in receiver threshold caused by an audio subcarrier posed an undue risk. Therefore it was decided that the audio should be transmitted in the telephone transponder to be received via a module inserted in the SCPC equipment.

Using the tentative bush TV parameters six receivers from various manufacturers were tested in the summer of 1976. Some improvement in threshold performance of the best receivers was noted, and both labratory and over-the-satellite tests using a small earth station showed excellent results. The parameters were adopted for the initial demonstration project, since they gave excellent picture performance and provided a conservative safety margin in case field experience showed that to be necessary.

Using a sampling of the three best TV receivers from the 1976 tests, the demonstration project was begun the next spring at 23 villages geographically disbursed over the state. The technical results were sufficiently encouraging that tests were conducted to determine optimum audio sub-carrier parameters. This was desirable for three reasons: 1)it is more economical than using a portion of a separate transponder for audio, 2)it is more operationally convenient, and 3)it had become apparent that receive-only earth stations would be constructed for television at locations which already had telephone service by other means and therefore would not need the SCPC equipment except to receive the TV audio. The audio parameters adopted are shown in Table 3.

3.2 THE DUAL-CHANNEL TELEVISION FORMAT

In addition, in an effort to further reduce cost and make the maximum service available to a citizenry starved for live television (particularly for sports and news programs), it was desired to bring in from the lower-48 two programs simultaneously, at least to the urban centers. However, the budget only allowed for lease of a single transponder. There existed at the time two methods of simultaneously transmitting two television signals through a single transponder—one was digital, and required hardware costing more than could be afforded; the other was the use of two fm carriers which shared the transponder's bandwidth and power. This method is inexpensive but results in some loss of quality due to a reduced video signal-to-noise ratio and video cross-talk between the channels. Neither method was suitable for use to small earth stations. The decision was made to pursue the two-carrier fm method, since the video signal-to-noise ratio was considered acceptable in light of having only one channel of programming as an alternative.

The cross-talk problem was considered serious, although there appeared to be several methods of reducing or eliminating it. In addition, the exact operational parameters needed to be developed, since other systems using the dual-carrier method operated with satellites having performance different than the newer Satcom spacecraft in several critical areas. These factors led to extensive experimentation over-the-satellite at RCA Americom earth stations in New Jersey and California in the latter half of 1976 and early 1977. From these experiments an optimum set of transmission parameters and a method of fully cancelling the subjective effects of video cross-talk were developed. The dual-carrier fm system was included in the 1977 Television Demonstration Project and continues in use to date. It provides approximately 3000 hours a year of live interstate television programming to the urban areas of Alaska, some of which is re-transmitted to the bush in that format.

4. THE LATE 70's: HIGH DEMAND AND RAPID GROWTH

Before all of the small earth stations were installed, local exchanges began to spring up. These provided the communities they served with greatly improved access to long distance service. For these villages, at least, the long lines of people waiting to use the telephone, which existed in many villages that had only a single circuit were eliminated. They also allowed incoming calls to be completed which was very difficult during times of high demand at villages having only a

single line. Initially the traffic carried by these exchanges was virtually all toll, with very little local calling. The number of bush earth stations serving local exchanges grew from one in 1976 to approximately 30 in 1981 with applications granted or pending for all remaining small earth station locations.

The stations also support a variety of private line traffic. Primary among these is the state's television program, which now uses separate transponders for entertainment and educational TV. Also there are a variety of voice-grade private lines in use, particularly for the Federal government.

5. FUTURE TECHNOLOGICAL NECESSITIES

The heavy use of the telephone capacity of the bush earth stations, particularly in providing toll circuits for local exchange service, would exhaust the transponder capacity in the near future if a fixed, pre-assigned mode of operation were continued. For example, when the number of exchanges in operation doubles to 60 exchanges, each with an average of 8 trunks, as could easily happen within 2 or 3 years, only 70 satellite circuits would remain to serve the requirements of the other 40 stations plus private line use.

At the point where the transponder is filled only two options exist: 1)move some stations to a second transponder, 2)institute demand assigned operation on at least some of the circuits. The first option would double the potential capacity of the bush network and ease the pressure for a time. However, it does not eliminate the existing undesirable affect of fixed assignment of satellite channels to only one earth station. There are two adverse effects of fixed assignment. One is that a call from a village to any other bush location must first be routed to Anchorage. There it is switched and sent back out to its destination, thus traversing the satellite twice and wasting capacity. Second, capacity is wasted by fixed assignment, since a channel in the satellite is available only to the earth station to which it has been assigned, even when it is unused. The nature of bush calling is such that a large proportion of calls is within a "community of interest" surrounding regional centers. Also, at any given moment, a substantial fraction of circuits will be idle due to the statistical nature of calling activity.

Demand assignment solves both of the problems inherent in fixed assignment operation. It works by assigning a satellite channel to an earth station only when that station "demands" a channel to meet a speciric need. After a channel is assigned, the "demanding" station uses it to establish a circuit directly to the destination earth station, thus eliminating the "double-hop" traverse of the satellite. After the call is finished, the channel is returned to the pool of idle channels for use by any station in the network. Traffic statistics are such that demand assigned operation gives five to fifteen times the effective circuit capacity as can be obtained through fixed-assignment, Figure 4.

The earth stations can be retrofitted for demand assignment operation since channel selection in the SCPC equipment is fully frequency synthesized and designed for external control via an interface similar to that used in microcomputers in common use today.

6. CONCLUSION

Perhaps the most interesting aspect of the Alaska bush earth station program is that it has been a technologically driven program from the beginning. At each step of implementation, including those to come, it has been, and will be, at the leading edge of available technology. This has come about not because the utilization of the newest technology was a goal in itself, but because there were no alternative well-trodden paths to follow.

TABLE 1

PARAMETERS FOR SINGLE CHANNEL PER CARRIER TELEPHONY USING SMALL EARTH STATIONS

Uplink - 6 GHz		
Spacecraft single carrier saturation flux density	-85.0	dB/m^2
Single carrier to noise density	+101.6	dBHz
Optimum input backoff	-6.9	dB
Total uplink multiple carrier to noise density ratio	95.6	dBHz
Number of active uplink carriers, 417 carr. (10 log 417=26.2)	26.2	dB
Uplink noise density per carrier	69.4	dBHz
Space loss	-200.2	dB
Spacecraft G/T	-5.0	dB/K
Boltzmann's constant	-228.6	dBW/HzK
Earth station EIRP per carrier	46.0	dBW
Earth station antenna gain	46.3	dBi
Transmission line loss	1.4	dB
Transmitter power per carrier	1.3	Watts
Downlink - 4 GHz		
Spacecraft single carrier saturated EIRP	+36.0	dBW
Optimum output backoff	-3.4	dB
Space loss	-197.0	dB
Earth station G/T	19.8	dB/K
Boltzmann's constant	-228.6	dBW/HzK
Total downlink multiple carrier to noise density ratio	84.1	dBHz
Total carrier to intermodulation noise density ratio	84.6	dBHz
Overall carrier to noise density	81.2	dBHz
Required carrier to noise density per carrier	55.0	dBHz
Number of active carriers, 417*	26.2	dB
Total carrier to noise density ratio per channel	55.0	dBHz
Peak test tone deviation	5800	Hz
Top baseband frequency	3400	Hz
Test tone to noise ratio	31.8	dB
Pre-emphasis advantage	6.0	dB
Companding advantage	16.0	dB

C-Message weighting	2.0	dB
Overall test tone to noise ratio	55.8	dB
Channel noise (equivalent)	2630	pWp0
Margin relative to 10,000 pWp0	5.8	dB

* Talker activity is approximately 40 percent of the time. Thus by turning the transmitter on only when a caller is talking, the number of channels which can be supported is multiplied by 2.5 giving 1042 channels. Usable transponder bandwidth is 32 mHz, channel spacing is 30 kHz, giving 1066 assignable channels.

Table 2

PARAMETERS FOR BUSH FORMAT TELEVISION

Peak video deviation	8.0	mHz
Video pre-emphasis	CCIR-405	
Energy dispersal deviation	0.8	mHz
IF Bandwidth	20	mHz

LINK BUDGET FOR BUSH FORMAT TELEVISION

Spacecraft saturated EIRP	36.0	dBW
Downlink path loss (4 GHz)	-197.0	dB
Earth station G/T	19.8	dB/K
Boltzmann's constant	-228.6	dBW/HzK
Downlink carrier to noise density ratio	88.0	dBHz
Uplink carrier to noise density ratio	104.5	dBHz
Combined carrier to noise density ratio	87.8	dBHz
Receiver threshold	85.5	dBHz
Margin above threshold	2.3	dB
Margin required for 0.99 avail.	1.2	dB
Implementation margin	1.1	dB
Demodulated video signal to noise ratio*	47.9	dB

* The video deviation chosen for this service was 8.0 mHz-Peak as contrasted with the approximately 11 mHz-Peak deviation used with large earth stations. The IF bandwidth required for fm transmission of video is approximated by 2 times peak deviation + top video baseband frequency (from Beakley) or 2*8 + 4 = 20 mHz.
Video signal to noise is related by:
Video $S/N_{pp\text{-}rms} = C/N_0 + 20 \log Pk\ Dev - 58$

Table 3

BUSH FORMAT AUDIO SUBCARRIER PARAMETERS

Subcarrier Frequency	5.8	mHz
Deviation of main carrier by subcarrier*	1.5	mHz
Deviation of subcarrier by audio: program peak	75	kHz
absolute peak	225	kHz
Subcarrier filter bandwidth	600	kHz
Pre-emphasis	75	uSec

* Produces audible click threshold approximately 2 dB below video impulse noise threshold.

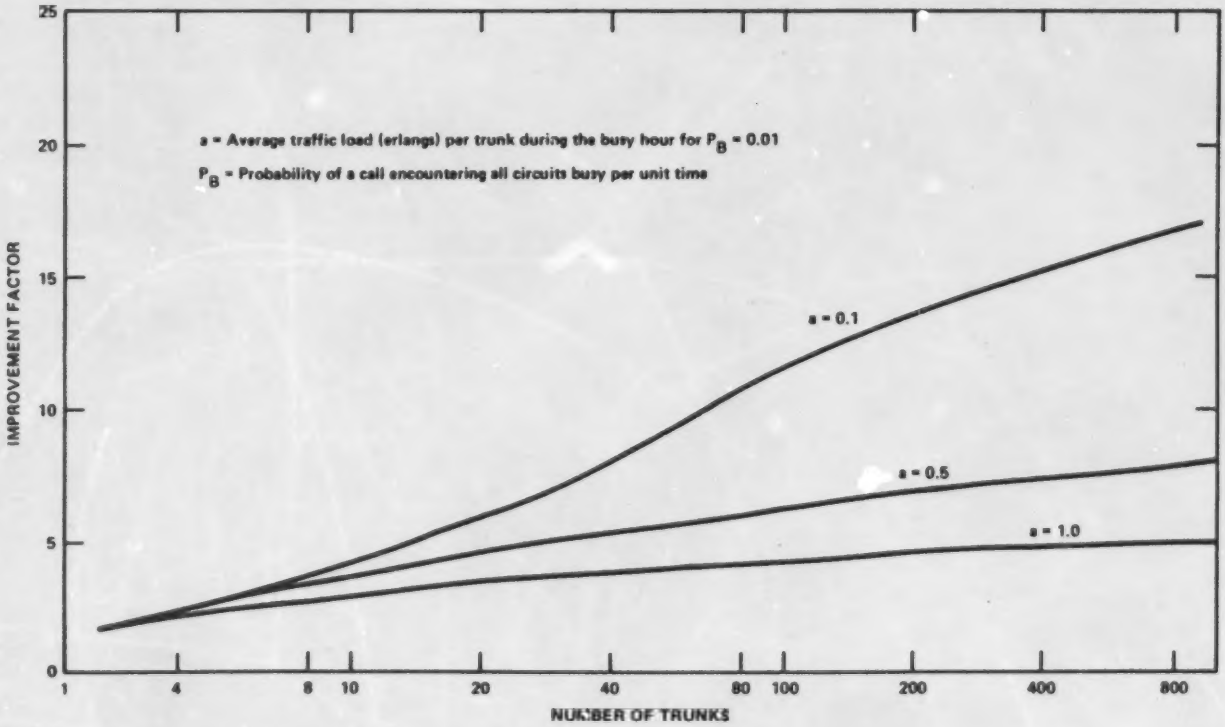

Figure 1 Improvement Factor for Demand-Assignment Operations.

LOCAL EXCHANGE GROWTH IN BUSH ALASKA

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ABSTRACT

Local exchange provides the first and the last link for a customer connection in the telephone network hierarchy. Growth in the overall demand for telecommunication services is a direct result of the availability and accessibility of the network through additional subscriber access points.

Penetration of telephone telecommunications in Alaska, therefore, is related to the ultimate growth of the local telephone network. Since this is also where majority of plant investment is concentrated, a cost benefit trade off is necessary. From less than forty exchanges in 1970, to 160 local exchanges serving 300,000 stations with two new exchanges projected to be turned up per month for next five years, Alaska is truly vying to provide universal telephone service at affordable rates.

HISTORICAL BACKGROUND

Prior to 1970, as described in the accompanying papers, majority of telephone communications in Alaska was processed through White Alice Communication System (WACS) operated by the Air Force. There were only a handful of local exchanges serving the metropolitan areas and large population centers. Communication at the local level was through HF radios, personal message carriers, smoke signals and whatever else one could get hold of. Alaskan telecommunications was as backward as the other side of the moon.

After the sale of the WACS System to RCA Alascom, one of the objectives of the state government was to get a minimum level of telephone service to over 120 small communities and improve toll accessibility to the larger centers. Alascom, the only authorized long limes carrier, installed Improved Mobile Telephone System (IMTS) during 1971-1975 to serve over 50 communities wherein one telephone channel was shared amongst five to six villages. Switching of calls was done through then existing exchange centers owned by the larger municipalities and large holding companies.

With one toll link serving five villages or more, call completion rates of 10-15% were not uncommon. Any additional network loading would, therefore, further compound the problems and add no improvements for the customer or the network. Up to this point, installation of local exchanges did not quite make sense.

During pipeline and post pipeline era, with the booming economy and population growth, State of Alaska and Alascom entered into an interim agreement for installation of 100 small earth stations to augment this IMTS program and improve accessibility to the toll network. One telephone channel with a telephone at the end of this channel for toll access was installed in 100 villages during 1976-1980.

The installations of small earth stations (4.5M:SCPC FM) provided the necessary catalyst for potential local exchange carriers to explore extending services for house to house telephones in these small communities.

In 1976 OTZ Telephone Cooperative, based in Kotzebue (Northwest Alaska) applied to provide local exchange service to nine villages surrounding Kotzebue using small earth stations for network access. Alascom opposed their application based on the financial feasibility of the project and additional investment needed on their part to upgrade the earth stations. However, the Alaska Public Utilities Commission (APUC) overturned their objections and ordered Alascom to provide interconnect. By 1978, United Utilties, Interior Telephone Company, Arctic Slope Telephone Cooperative, Bristol Bay Telephone Cooperative and Mukluk Telephone Company had filed applications or were certificated to provide exchange service to over 60 additional villages, starting the explosive growth of local exchanges in Alaskan Bush and laying the framework for universal telephone service.

ALASKAN BUSH

Alaskan bush consists of small village communities with population ranging from 25 to 600 people. The residents are Eskimos or Alaskan Indians. The village communities are located along the Bering Sea Coast, the Yukon-Kuskokwim Rivers and Delta, the Koyukuk River, the Aleutian Peninsula and Interior Alaska. Accessibility to these communities is via small plane or river barges. There is virtually no road system linking any two villages and travel during summer months is based on water and during winter over frozen ground, rivers, lakes et cetera. The bush is mostly devoid of vegetation except some alder bushes, tundra and flat watery terrain. Most of the population concentration is along the flat delta areas for accessibility via water transport.

Economy of these communities is based on subsistance hunting and fishing, commercial fishing, some small scale cottage industry, governmental services

and transfer payments. Average family income in the area is $10-12K/year, basically below national poverty standards, considering the increased cost of living. Family size varies from four to ten people and there is a greater dependence on outside world for supply, medical, education, transportation, et cetera. Even though the community and individuals have limited financial resources, telecommunications plays an important part in the economic development of these areas. In addition, telecommunications are essential for public administration, safety, health and well being and provide an information system that creates an important link between the differing cultures and life styles.

ALASKAN TELEPHONE COMPANY STRUCTURE

Alaskan telephone industry consists of four ownership structures. a) Large municipal owned systems e.g. Anchorage, Fairbanks, Ketchikan serving over 60% of the total main stations in Alaska; b) Multinational holding companies e.g. General Telephone, Continental serving over 20% of the telephones; c) Locally owned cooperatives e.g. Matanuska, Arctic Slope Cooperatives serving about 10% of total stations and d) Locally owned privately held companies e.g. United Utilities, Interior Telephone et cetera serving less than 5% of the total main stations.

It is the last two groups in this category representing less than 15% of the stations that service over 90% of the Alaskan land mass with local exchange service and are truly the independent pioneers serving and trying to achieve the universal service criteria. Arctic Slope Cooperative, OTZ Telephone Cooperative, Mukluk Telephone Company and United Utilities, Inc. combined have a service area comprising 300,000 square miles of the most rugged and harsh terrain and a population density of one person per ten square miles.

Average number of customers per local exchange is under 100 and average number of toll trunks serving these exchanges varies from four to ten.

Most of these telephone companies provide single party residential and business service, direct distance dialing using an access code, automatic number identification, back up battery power and full range of sophisticated features such as call forwarding, abbreviated dialing similar to those provided by the larger exchange systems in metropolitan areas.

The companies or cooperatives serving these areas are financed through low cost money borrowed from Rural Electrification Administration, U.S. Department of Agriculture. Operating capital is obtained through affordable local rates and toll settlements through the nationwide toll poll.

TELEPHONE COMPANY PLANT

Due to newness of plant that is being put in service, latest state of the art equipment and construction techniques are employed in bush Alaska. The areas served by these bush companies are inaccessible by road systems, are limited to the length of runways for air transport and are constrained to a short rainless summer season when supplies can be delivered and construction completed. Normally this period ranges from 120 - 150 days.

Construction techniques commonly employed are discussed below:

BUILDINGS: Three major construction techniques are employed for building construction.

1. Pre-Fabricated fully assembled buildings.
2. Pre-Constructed knocked down buildings.
3. Stick Construction.

Pre-fabricated fully assembled buildings, sometimes with equipment in place and fully tested are used at locations accessible to heavy machinery and easily transportable via tracked machines over village roads or lifted by helicopter to its final location. This technique has the advantage of low initial labor cost but high overhead cost for setting the buildings in place.

Pre-constructed knocked down buildings avoid the expensive handling of fully constructed buildings, use lower local labor costs but are subject to construction delays due to missing, wrong or defective piece parts e.g. if part of a wall was damaged, the whole building could be exposed to weather and play havoc with construction costs.

Stick construction commonly employed in the bush is more labor intensive, less overhead but more flexible in areas where getting one pound of sheetrock nails could cost over $300.

Each company devises the most cost effective technique for its service area.

The foundation system for most building is either a Post & Pad arrangement that is placed over the undisturbed tundra, pilings to perma frost or rock or by underlayment removing the overburden and using insulated expensive gravel pads. Gravel in some of these areas sells from $50 to $100/yard as it is to be hauled by barge 200 miles.

OUTSIDE PLANT

Loop plant for exchange operation is either a) Aerial; b) Buried; c) Surface Utilidor or a combination of the above techniques.

Aerial plant uses Figure 8 cable or lashed cable of various pair sizes in 22-24 gauge cable. This plant is susceptible to high wind damage and physical abuse. Pole holes have to be hand dug if machinery cannot be transported.

Buried plant is more suitable for communities where it can be plowed or trenched by machinery. Transportation costs of machinery and helter-skelter layout of existing houses is a detriment. Buried plant is also subject to shear from move-

ment of active frost line above the permafrost.

Surface utilidors are employed as a quick fix soulution for reducing initial investment. These systems can be put together by relatively unskilled labor and run in any radial direction based on the location of houses. These utilidors are, however, subject to high maintenance, physical abuse and pilferage.

EXCHANGE EQUIPMENT

The exchange equipment employed in the Alaskan Bush is either electronic wired logic or digital software systems. The initial cost of this exchange equipment for the small line size required restricts the number of suppliers available to fill this market. Majority of these exchanges are modified PBX Equipment and are limited to the loop lengths and transmission characteristics.

Due to relatively unskilled maintenance personnel, pluggable easily replacable equipment with remote maintenance alarm, connect/disconnect are preferred for this environment. The prime power is supplemented by 8-16 hours battery backup. The equipment is configured for 7 digit local calling and full 1+, 0+, 0- toll dialing, pay stations, and other test features required in the class 5 switching systems. Suppliers presently meeting these needs are Stromberg-Carlson, Digital Equipment, REDCOM Laboratories, Plessey and Vidar.

TOLL INTERFACE

Toll interface for these exchanges is provided by small unattended, non-redundant 4.5 meter antenna earth stations using FM single channel per carrier. A few 2 GHZ microwave links or 450 KHZ radio systems have also been used, in areas where several villages can be clustered and handled via one large diameter (10m) antenna using FDM Techniques.

The present method of toll switching requires calls to be routed and switched through a class 4 center located in Anchorage. Due to a large community of interest, amongst adjoining villages, double hop is frequent. This poses transmission delays and unacceptable echo on some circuits. Demand assigned multiple access techniques (DAMA) to be introduced in future shall eliminate some of these problems.

STATION APPARATUS

Due to changing regulatory environment, station equipment employed is fully modular pluggable type. Medium to heavy duty gas tube protectors are used at station entrance. Even though lightening is not a common occurence, it does occur. The major problem is poor ground conductivity and improperly installed electrical systems, subjecting the customers to electrical hazards.

UNITED UTILITIES EXPERIENCE

As one of the several bush exchange carriers operating in Alaska, United Utilities, Incorporated has had gratifying experience in extending local telephone service to these communities. From its inception in 1978, United Utilities is now operating twenty exchanges and has a customer base of about 2,000 stations. Using local native labor for construction and maintenance, United Utilities is building a pool of skilled personnel who will be stepping into the Twentieth Century with a better understanding of communications technology and information based systems. The penetration rate of service in most villages is over 90% and a connect/disconnect rate averages 4 to 5%. Collection of toll bills is good and uncollectibles are below 4%.

Customers who had never used telephones previously are wanting chime ringers, abbreviated dialers, key systems, mobile telephone systems and hands free telephones. Introduction of technology has been much easier than predicted. Acceptance of telephone as a working tool in business and commerce is improving general economy and cost of living is being reduced by able to take advantage of bigger market place.

Efficiency of household operation is rising as separation of residence from workplace becomes unnecessary. United and other carriers are planning to integrate the local and toll connecting links in each community to better use the plant for providing Data, CATV, Electronic Mail and other futuristic services that will be needed in an information based society of the near future. United's experience over the past two years is portrayed in the attached graphs and photographs.

CONCLUSIONS

Local exchange growth in Alaska Bush is bringing affordable telephone service to those residents of the state who previously had no access to telephone or one telephone for the whole community of up to 600 persons. The cost of this service is by no means small, but the benefits are proportional. Development of economy, health, safety and well being of the residents requires adequate access to the market place and suppliers of these services including government administrations.

The catalyst for this growth has been aggressive state policies in telecommunications, federal financing, entrepreneurship plus a growing role for Alaska in the national scene. It is not long before every inhabited community in Alaska shall be served by a telephone outlet.

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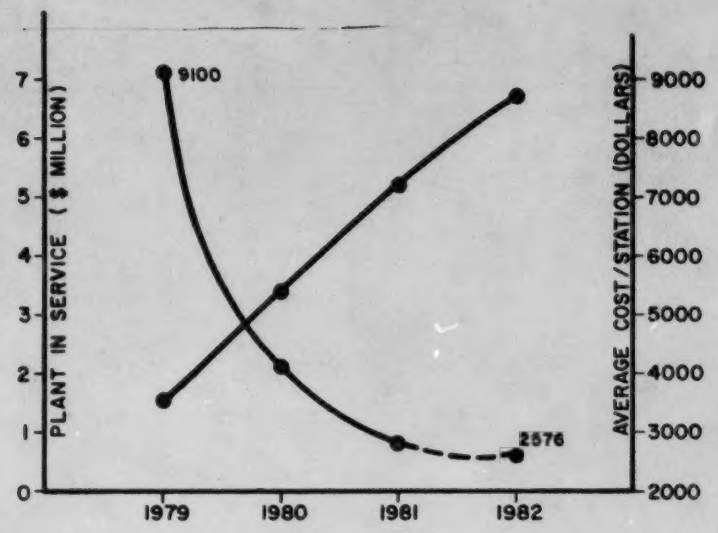
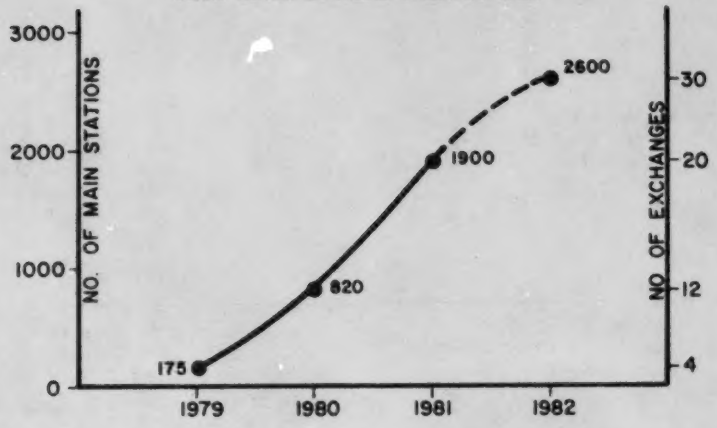
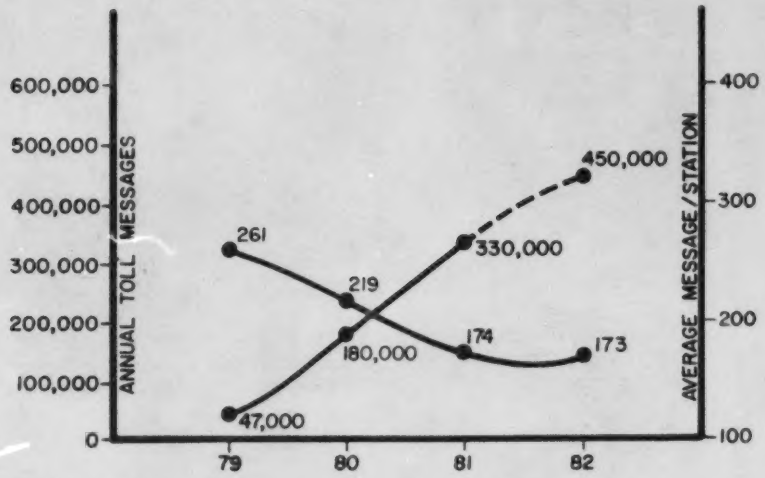


PLANT GROWTH IN UNITED'S SERVING AREA



MAIN STATION GROWTH IN UNITED'S SERVING AREA



TOLL MESSAGE GROWTH IN UNITED'S SERVICES

University of Alaska Electronic Mail Communication

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1. Abstract

To facilitate communications to its geographically scattered campuses, the University of Alaska implemented electronic mail. The service provides easy and dependable instantaneous communication over enormous distances for students, faculty, administrators and support staff. Electronic mail has become a reliable, cost effective answer to university communication needs.

2. THE COMPUTER AND ITS USES

In 1976, because of physical barriers to statewide communication, the University of Alaska inaugurated electronic mail as part of its Honeywell computer network. Electronic mail on the University of Alaska Computer Network (UACN) is a subsystem of the timesharing system. Timesharing allows multiple users (up to a practical limit of 120) to simultaneously access the computer, share its resources and obtain responses from any of the three four-year and 10 community college campuses of the university. UACN serves a total of 7000 students, faculty, staff and administrators throughout the state (of the total, 5300 are students). The network itself consists of minicomputer concentrators, called "nodes," for remote job entry on the Anchorage, Fairbanks and Juneau campuses. Each node is connected by means of satellite and microwave communication lines to the large dual processor Honeywell computer in Fairbanks. (See Appendix A for a description of the central site.)

Two unique management aspects of UACN are the extreme distances involved, and the fact that all users are treated equally. The network is managed in accordance with the Dartmouth philosophy of rapid turnaround and heavy emphasis on timesharing. Since all users have access to the system through nodes, each is assured physically equal facilities. Remote users are not charged extra for communication, and all users are assigned equal priority on the system. All registered students, faculty, administrators and staff have free, but not unlimited, use of computer resources. To initiate a timesharing session, the user must have an account, or "userid," (for user identification) which is obtained at the user's local site. For example, a student one-semester account has $100 of available time, which can be spent in any manner the student desires. For class assignments, a student is provided with additional time.

3. ELECTRONIC MAIL

Electronic mail is the process of sending data (messages) from one location to another, usually via telecommunication. To make communication possible, both the sender and the receiver must have access to computer terminals, and must have active userids with the university. For most users, the University of Alaska "MAIL" subsystem is their first real computing experience. In a one-hour session, a new user can be taught how to sign on with a terminal and how to execute rudimentary MAIL commands. Then the user can actively communicate.

Actual development of MAIL began on UACN in 1976, and was designed by local staff in conjunction with work at the University of Waterloo,Ontario, Canada, and Wayne County Community College, Detroit, Michigan. Several versions have been implemented with most of the programming in GMAP (Honeywell General Macro Assembler Program) language. While MAIL was designed specifically for UACN, many comparable electronic mail programs and services are commercially available.

Who uses electronic mail? Students can use the computer informally for electronic "pen pal" communication, or a dating service. Faculty can send messages to an entire class or to an individual student, carry on a dialogue with a colleague or utilize the system as a teaching aid. Administrators find mail a safe, reliable and inexpensive way to communicate with other statewide campuses. University support staff utilizes the system with the same ease as typing, and in many cases can eliminate the cost of making long distance calls. A few federal, state and local government agencies also utilize UACN for research, and for them, the mail system may be the most practical link to a computer center consultant.

4. CAPABILITIES OF "MAIL"

MAIL permits any authorized user to send messages or files containing messages to any other

user's "mailbox." Each mailbox is created automatically, and the user does not need to know technical details of computer storage. There are no complicated lists of commands to memorize or reference in manuals. (See Appendix B). Upon "signing on" to the computer, the user is notified of any unread waiting messages. The user can then select to read a message by printing it out at a terminal, and can then decide whether to answer the message, retain it indefinitely or delete it. MAIL allows the recipient to reply immediately if the sender of the original message is still using the computer. It is not necessary for both the sender and receiver to be using the system at the same time to complete a message transaction. Most important, MAIL creates a unique conversational environment among users who would otherwise remain isolated.

Specific capabilities include sending and receiving "registered" mail, with the date and time of the mail acknowledgement returned to the sender, just like the green card from the postal service. A user can "forward" his mail to another user. The sender can use "carbon copy"-like features to transmit the same message to more than one user. Furthermore, the sender can build a file of userids, and send a message to that entire group of users-- a committee, a class or a group of friends. (See Appendix C for samples of sending mesages.) Sometimes it is desirable to send a specially formatted message to one or more users. In this case it is advisable to create a file using a text editor, and then use MAIL commands to send it. There is no practical limit to the number of messages a user can send and receive. In October 1980 alone, about 85,000 messages were sent.

5. ELECTRONIC MAIL AS A COMMUNICATION MEDIA

For the University of Alaska, MAIL has proven far more reliable and timely than the U.S. Postal Service or telephone. The system has been reasonably secure, enough so that the university president uses it. Messages are readily available to the receiver at his convenience. After justifying the computer on the basis of academic, administrative, and research needs, at a cost of in excess of $3 million, the MAIL system has been very cost effective. A first class letter via the postal service costs $.20 for one ounce. A daytime three-minute phone call from Anchorage to Fairbanks is $1.65 plus tax, while a 30-line MAIL message can be sent for $.05 (charges are automatically deleted from the sender's computer account). Since the network spans three geographic time zones, MAIL provides a communication link that does not require the receiver physically to be on the other end. A message does not have to take several days for delivery, as required when using the postal service.

One of the most exciting uses of MAIL has been for computer conferencing classes. A class can be taught on one campus, and students from any other campus participate via MAIL. The class could also use audio conferencing for verbal communication with the instructor.

The concept of delivering MAIL is quite different from that of physical mail. The receiver does not have to physically be at his home campus in order to have messages delivered to him. He can sign on any terminal, at any location, and check his MAIL. Thus, a traveling administrator is never far away from his messages. Furthermore, by using a terminal, a modem and UACN dial-up lines, a receiver can obtain his MAIL at home. Of course, a sender could also send from home. If a user is willing to pay the phone charges, MAIL becomes world wide.

6. DRAWBACKS

No paper mail system is completely secure, and neither is any electronic mail system. In one unfortunate incident, an obscene message was once sent to 1000 university users chosen at random. With electronic mail, abuses may happen more swiftly and with greater impact than in traditional systems.

Access to the computer is sometimes a problem. At any one time, usually 20 percent of all terminals are sending or receiving mail. Since the computer is limited to the number of terminals (120) which may simultaneously access the computer, other computing requirements may go unmet. Furthermore, many public access terminals are located in buildings which may not be open 24 hours a day or seven days a week, like the computer is.

7. THE FUTURE

In 1976, the university could not have justified a dedicated mail computer; however, that concept has recently been suggested in an attempt to improve and expand all computing services. MAIL has become an easy and dependable instantaneous method of communication within the university community.

8. APPENDICES

APPENDIX A. HONEYWELL COMPUTER CONFIGURATION

The central site machine room is located on the Fairbanks campus and contains the following:

* Dual Honeywell 66/20 mainframes with 384K of MOS memory housing the central processors
* Two system control units
* Two input/output multiplexers
* Two micro-programmable peripheral controllers
* Dual 66/24 front-end processors
* Six nine-track tape drives
* Nine double-density disk drives with 500 megabytes each
* One 1200 lines per minute printer
* One card reader
* One card punch

Each of four nodes has a Honeywell 707 or 606 minicomputer, a printer and a card reader. Some nodes have nine-track tape drives and additional line printers. Eventually every node will be equipped with a hard-copy plotter. The network also has a variety of timesharing terminals for public use, including a few with graphics capability. Some terminals are available 24 hours a day; access to others is generally dependent on building hours. The computer itself is accessible 24 hours a day, with only six hours downtime a week for preventative maintenance.

APPENDIX B. SAMPLE COMMANDS

Command	Function
C	Create a mailbox
clear	Remove all unread messages
D	Delete a specific mesage
H	Help with MAIL
K	Kill a message just sent
L	List messages
P	Print (read) a message
Q	Quit, get out of MAIL
R	Reply to a message
S	Send a message

C. EXAMPLES OF CAPABILITIES

Sample 1. (Send a message to a user)

```
+S FFJPDOE (receivername)
.Dear John,
.          .
.          .
.   (any text)
.          .
.          .
.Thank you,
.Sendername
.
#17 FFJPDOE
```

After signing on and calling for the MAIL subsystem, the sender sees a "+" prompt on his terminal. He then enters any valid MAIL command and ends the line (and every line) with a carriage return. (The carriage return does not print a charater on the screen.) If the receiver has a userid, and a functioning mailbox, the computer will send a "." prompt to the sender's terminal.

At this point, the sender enters the text of his message, in effect, using the terminal just like a typewriter, ending each line with a carriage return. The "." prompt is just a guide, and does not print on the receiver's final copy. To finish the message, the sender enters a carriage return immediately after the "." prompt. The 17 indicates that Fairbanks faculty member J.P.Doe (FFJPDOE) now has a new message to read (the 17th one in his mailbox).

Sample 2. (Send a registered message to an established file of users, ie, carbon copy.)

```
+SR %MATHDEPT
.Dear colleague,
.          .
.          .
.    (any text)
.          .
.          .
.Thank you,
.sendername
.
#1 AFQLJONES
#4 JFFMSMITH---Mailbox Full
      .
#17 FFJPDOE
```

In this case, the same sender designated "registered" mail by the command SR. The "%" determines that the Math Department (MATHDEPT) is a file of userids, not a user. The computer will print the results of each attempt to send the same message to all the math teachers, including Anchorage faculty member Q.L.Jones, Juneau faculty memeber A.B.Smith (JFABSMITH) who needs to clean out his mailbox, and Fairbanks faculty member J.P.Doe (JPDOE). A mailbox must be cleared of old, unwanted messages to keep the mailbox open.

METEOR BURST COMMUNICATIONS

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1. Abstract

Meteor burst communication systems provide a means of transmitting data over ranges of up to 1900 km. Typical applications of systems are described. Properites of meteor ion trails and their effects on radio propagation are reviewed.

2. INTRODUCTION

2.1 THE MEDIUM

Meteor burst communications uses trails of ions left by meteors in the upper atmosphere to reflect or reradiate VHF radio signals to points beyond the normal line-of-sight radio horizon. Since most meteor ion trails disappear in less than a second, short sequences of data, rather than voice signals, are transmitted. Meteor burst communications systems serve well at remote locations where the distance to communicate is 1900 km or less, where the data traffic load is modest, and where the supply of power may be intermittent or at a premium.

2.2 AN EXAMPLE

For several years now, hourly weather data have been transmitted over a meteor burst communications link from a remote wilderness lodge at Chandalar Lake, Alaska, directly to Anchorage, some 700 km to the south. At a desk-top terminal in a corner of the log lodge, the camp caretaker, who also makes the weather observations, enters and edits, through a standard typewriter keyboard, a sixty to one hundred-character report. When satisfied with its accuracy, he releases the report for transmission and leaves the terminal to attend to his other duties. In Anchorage, a master station continually broadcasts an invitation to Chandalar Lake, and to any of numerous other remote terminals, to transmit its report. None of these invitations reaches the lodge's equipment, however, until a meteor of sufficient size strikes the atmosphere in a region of the sky which is visible from both Chandalar Lake and Anchorage. Within the lodge's desk-top unit are storage batteries, a VHF transceiver, and a mircroprocesser with its memory. The associated antenna, a two-element Yagi spanning four meters and mounted on a seven-meter tower, faces Anchorage and points somewhat above the horizon. Several minutes after the caretaker releases his report, the awaited meteor strikes the atmosphere and creates a radio connection between the Anchorage master station and Chandalar Lake. The invitations to transmit are converted to a digital format by the VHF receiver, and the microprocessor, guided by its program, keys the VHF transmitter and begins sending the caretaker's stored report. The microprocessor sandwiches the first sixteen characters of the report between some timing bits and a message checking character, and sends them to Anchorage over the now decaying meteor ion region. The Anchorage master station compares the message checking character with the sixteen received message characters, and, if satisfied with the accuracy of the transmission, acknowledges the receipt of the first message segment with a coded return transmission to Chandalar. In a similar manner, the remainder of the caretaker's report is moved to Anchorage in segments of sixteen characters. The entire report is frequently transferred over a single meteor trail in less than one-half second, although sometimes an interval of minutes and several meteor events may be needed. Upon completion of the transfer, the terminal indicates to the caretaker that his report was successfully delivered.

The lodge is also equipped with a high frequency single sideband radio which was the former means of delivering the weather observations. The caretaker and the Federal Aviation Administration are both pleased with the meteor burst communications method which operates with little bother, has proven quite reliable and error-free, and deposits the data directly into FAA's weather collection system.

The camp generates its own power around the clock, although it would not need to for the sake of the meteor burst communications system, since the internal batteries need only be trickle-charged intermittently. The meteor burst communications system is quite energy conservative in comparison with other possible radio communication methods.

3. A BRIEF HISTORY

3.1 EARLY SCIENTIFIC WORK

Meteor burst communication has been applied to practical data transmission for only the past eight or ten years. The reader will appreciate that only with the integrated circuits and computer components available today, could one make practical use of the short time window during which a radio path exists. In 1946, a report of scientific work was published which indicated the effect of meteor trails on radio propagation. Interest soon ran high in the scientific community, and radio signal probes came into use as a

means of studying meteors and the upper atmosphere. Investigations of VHF ionospheric scatter during the 1950's uncovered the presence of large number of meteor ion trails which propagated radio signals and much was soon learned about the radio properties of meteor trails. Experimentally inclined radio amateurs re-confirmed the presence of meteor-caused paths, but rarely could communicate over the short-lived paths.

3.2 EARLY DEVELOPMENT

The United States government supported much of the early developmental work which serves as a foundation to the meteor burst communications systems in use today. In 1970, the Bonneville Power Administration turned up an experimental meteor burst communications system which was built by the Montana State University. During the first year's test, dummy messages were collected by a master station near Vancouver, Washington, from several remote locations up to 1300 km distant. The RF power transmitted from the master station, which was normally 100 watts at about 40 MHz, was varied from 90 to 300 watts to determine the effect upon the rate of message transfer. Yagi antennas of 9 dB of gain were used. The receiver thresholds were set at various levels between one and three microvolts. The investigators concluded that meteor burst communications suited their remote data collection needs.

3.3 THE SNOTEL NETWORK

A period of drought in the western United States during the mid-1970's helped focus the interest of the U.S. Congress on the Soil Conservation Service's collection of mountain snowpack data. Since the mountain snowpack accounts for more than 70 percent of the water supply for the semi-arid regions of the western United States, such data are extremely important to the management of water resources and for the planning of future crops. Studies indicated that an automatic data collection system using meteor burst communication was cost effective, and a project was approved.

Today, SNOTEL (for SNOwpack TELemetry) comprises over 500 remote meteor burst communications terminals, with master stations at Boise, Idaho, and Ogden, Utah. The remote sites are powered by batteries which are charged by solar cells. Each remote site is read twice daily, and, if desired, can be read more often. SNOTEL represents the most extensive meteor burst communications system in use in the United States today.

3.4 THE ALASKAN FEDERAL NETWORK

In 1974 and 1975, a group of federal agencies and several oil companies jointly sponsored a summer and a winter test of meteor burst communications in Alaska. The results indicated that data could be collected reliably, once an hour, from each remote station in a network of several hundred stations in Alaska, throughout the day, and throughout the year. During periods of strong auroral activity or of magnetic disturbances, some degraded system performance was noted.

The favorable outcome of the tests led to the choice of a meteor burst communications network to support a system of automatic hydrologic observing stations along Alaska's rivers. Many of the proposed sites lay in valleys, out-of-sight of geostationary satellites and existing microwave facilities. The meteor burst method eliminated the need for repeaters, allowed the use of relatively low cost remote terminal equipment, had power needs which could be met with solar cells, and required only inexpensive, easily transportable Yagi or inverted V antennas. Soon, a consortium of federal agencies with similar telemetering needs had formed, and plans were laid for a master station in Anchorage.

The federal master station has been in operation now since 1978. Data are collected around the clock from approximately 25 remote terminals. In addition to telemetered data from fixed locations, ordinary office communications with fire fighting and surveying crews are exchanged through portable terminals set up in the bush. Weather data are also collected as described earlier in this article. Occasionally, test data for novel meteor burst applications pass through the Anchorage master station. In the past, for example, LORAN C coordinates have been transmitted from ships and from aircraft in flight, in a demonstration of a long range automatic vessel or aircraft tracking system.

3.5 PRIVATE SECTOR DEVELOPMENT IN ALASKA

Meteor burst communication service in Alaska presently remains the exclusive domain of its developers -- the federal government. Meteor Data Inc. was formed in 1979 to bring that service to industry and to the public. Operating under a development license, Meteor Data is completing the installation of its master station in Anchorage and will soon be able to lease remote terminals and service to anyone. The new facility is designed to provide point-to-point communications, as well as automatic data acquisition and remote control. The meteor burst technique is ideally suited for communicating over the vast, sparsely settled areas of Alaska, where isolation and harsh weather conditions increase the importance of reliable links to civilization. This new service is expected to open communications at locations throughout Alaska not now served by a communications carrier, and to provide backup capability at served locations.

4. SYSTEM DESCRIPTION

4.1 EQUIPMENT

A typical meteor burst communication system consists of a base station transceiver and a number of remote transceiver terminals as depicted in Figure 1. The base station comprises an antenna system, a VHF transmitter and receiver, a mini-

computer which serves as a central processor, and leased or dial-up circuits for input and output to users. The remote station may consist of instruments to be telemetered, or a keyboard terminal, or both; a microcomputer which performs simple processing; a VHF transmitter/receiver; a battery power supply; and antenna and diplexer systems.

4.2 OPERATING SCHEME

The system operates under the direction of the master station which transmits a series of "probes" to which a remote station might respond when a meteor-caused path occurs. If the probed remote station has traffic, it will send the first segment (on a slightly removed frequency). If the master station receives that segment and is satisfied with its accuracy, the master station will return an acknowledgment. If the remote station receives that acknowledgment, the remote station will send the next segment. The process continues until all segments of the message have been transferred. Remote stations which are programmed to receive, as well as to send traffic, respond similarly with an acknowledgment when correct message segments have been received.

4.3 METEOR BURST TECHNOLOGY

The techniques for designing and predicting the performance of meteor burst systems are well developed today. Generally speaking, data may be transferred at increasingly greater rates by raising transmitted power and, to an extent, by increasing antenna gain. The best range of transmission is from 950 to 1600 km, although coverage is complete from 0 to 1900 km. The best operating frequencies are from 30 to 50 MHz. The optimum data bit rate is a function of operating frequency, range, and message length. A transmission rate of 5,000 baud is typical. Antenna gain and transmitter power may be traded off. The cost of a transmitter sets a practical limit on RF output power to about 1000 watts. For ranges of 650 to 1950 km, antenna gains of 16 to 24 dBi should not be exceeded, as the radiated beam should be broad enough to include a high percentage of the usable meteor trails. Bi-phase phase-shift keying is a proven modulation method.

Meteor burst communication systems are weak signal systems with path losses on the order of 170 dB. Quiet receivers should be used and should be sited in quiet environments. Receiver sensitivity will be limited by galactic noise, rather than man-made, or internal receiver noise, when a proper receiver is favorably sited. Long messages are sent in segments which include error check characters. Segment length is optimized in accordance with other system paramters: too long a segment runs the risk of an extinct path before transmission completion; too short a segment wastes good path time with the overhead of synchronization bits and returned acknowledgments. Schemes for error correction are not used because the added overhead costs reduce the overall throughput.

5. PROPERTIES OF METEORS

5.1 KINDS OF METEORS

The earth's atmosphere receives a hail of evaporating meteoric matter every moment. At altitudes of 80 to 100 km, particles with dimensions ranging from 8 centimeters to 40 microns decelerate from velocities of 11.3 to 72 km/s and leave tracks of ionized gas, typically 15 km in length. The vast majority of these meteors, called "sporadic", move in random orbits around the sun and collide with the atmosphere from random directions and at random times. Their distribution along the earth's orbit varies, however, so as to collide with the earth four times as often in July, as in February. This variation is nearly sinusoidal and is the cause of the annual variation in message rate depicted in Figure 2. Unlike sporadic meteors, "shower" meteors travel in similar orbits and intersect the earth's orbit at particular times of the year. Their numbers, however, are too few, and often too variable from year to year, to contribute prominently to practical meteor burst propagation.

5.2 DIURNAL VARIATIONS

In addition to the annual variation of meteor occurrence just mentioned, a daily variation of rate, caused by the motion of the earth in its orbit, is responsible for an additional four to one variation in message rate. On the morning side of the earth, particles are swept up by the forward motion of the earth in its orbit; while on the evening side of the earth, only particles with sufficient velocity to overtake the earth will collide with the atmosphere.

5.3 EFFECT OF VARIATIONS

Variations in meteor frequency affect the waiting times of messages to be transmitted. Figures 3 and 4 depict the effect of the diurnal variation of meteor frequency upon the time a message must wait before completing transfer.

5.4 PATH DURATION

The usable duration of a meteor track depends upon many factors including the ion density of the track, the transmitted power and RF frequency, the meteor's relative position and the range between the stations, and even the dissipating effects of high altitude winds. Empirical knowledge, rather than exact analysis, is used to predict meteor burst communications system performance. In general, for practical systems, the useful duration of meteor tracks varies from a few milliseconds to a few seconds. Typically, the geographic pattern of the track-scattered energy available for receiving is a footprint-shaped contour, about 8 km by 35 km, with its major axis directed toward the transmitter.

The throughput rate of a meteor burst communications system increases with distance, once the terminals are beyond line-of-sight distance. A typical varia-

tion of throughput rate as a function of range is shown in Figure 5. At short and long ranges, performance is reduced because there is less common sky area, at meteor height, visible to the two stations.

6. CONCLUSION

With the present-day availability of microprocessor and other electronic components, the technique of meteor burst communication has come of age. Sufficient development work has been accomplished so that system performance can easily be predicted for proposed applications. The potential for use is highest where intermittent transmission of modest amounts of data is acceptable, and where the range between stations is from 0 to 1900 km. The input power requirement for remote stations may be made light, and the remote station equipment, including the antenna, may be made quite portable.

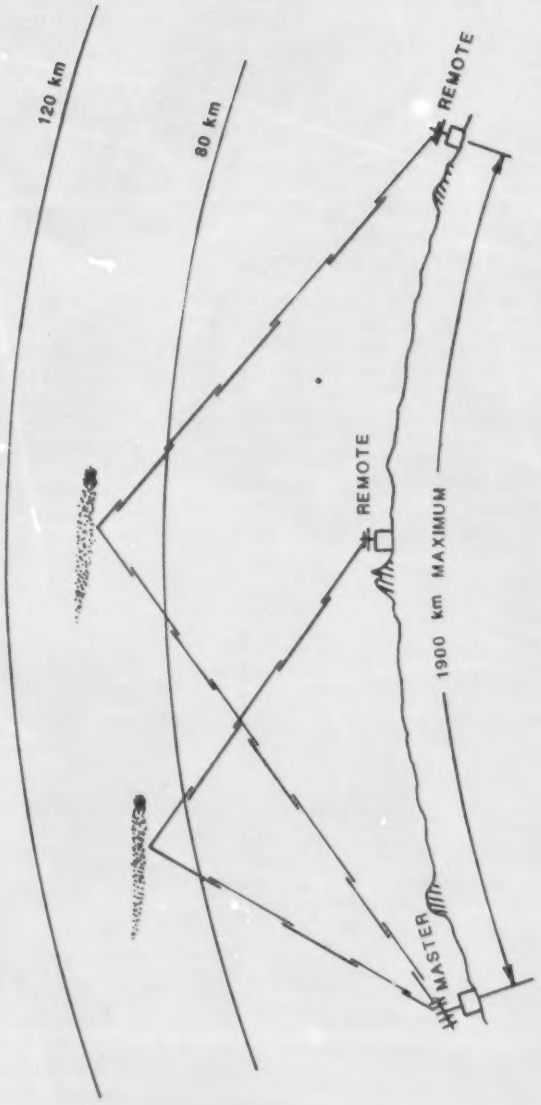

FIGURE 1. METEOR BURST COMMUNICATIONS SYSTEM

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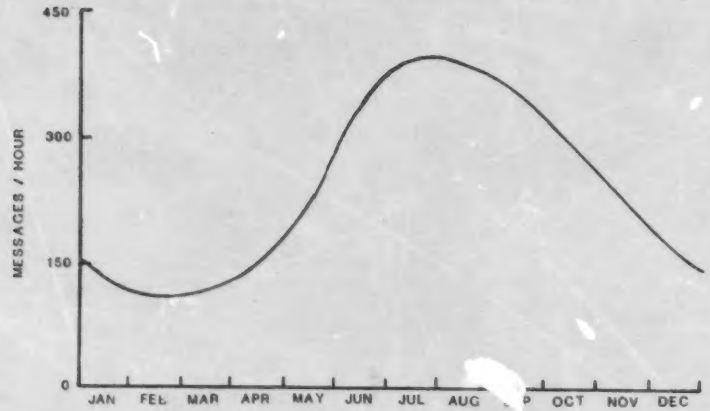

FIGURE 2. METEOR BURST COMMUNICATIONS SYSTEM
TYPICAL ANNUAL VARIATION IN MESSAGE RATE

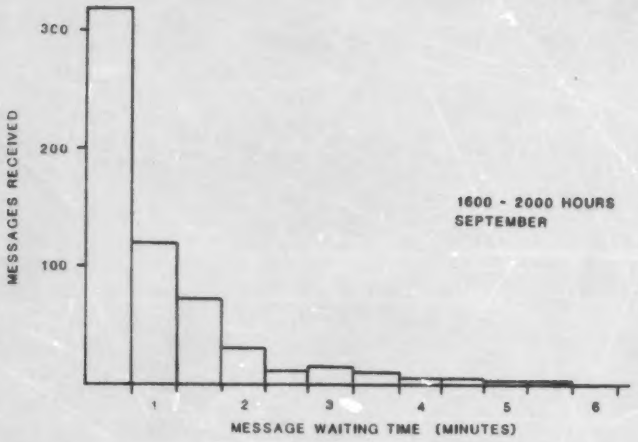

FIGURE 3. METEOR BURST COMMUNICATIONS SYSTEM
TYPICAL MESSAGE WAITING TIME, EVENING

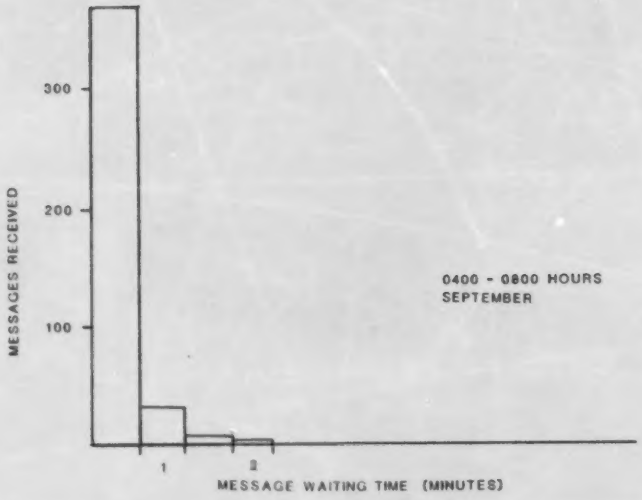

FIGURE 4. METEOR BURST COMMUNICATIONS SYSTEM
TYPICAL MESSAGE WAITING TIME, MORNING

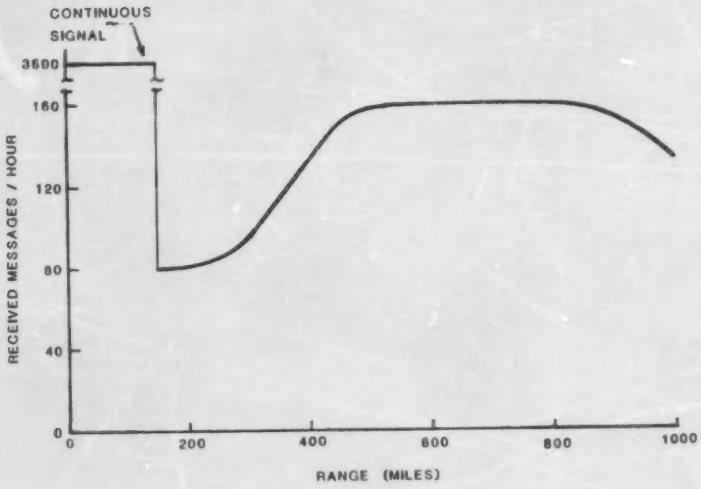

FIGURE 5. METEOR BURST COMMUNICATIONS SYSTEM
THROUGHPUT RATE AS A FUNCTION OF RANGE

COMMUNICATIONS ON THE NATIONAL PETROLEUM RESERVE - ALASKA (NPRA)

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Abstract

Reliable communications are vital to a modern, safe, and cost efficient petroleum exploration effort, especially in the severe environment of the Arctic. Earlier operations (1944 to 1945) were plagued with problems, and direct voice communication with points outside the Reserve was not possible. The recent period of exploration enjoyed radio and telephone communications between mobile seismic and construction trains, drilling rigs and construction camps, temporary survey and clean up camps, air-to-ground, the base camp, and all points south of the Reserve and outside the State of Alaska.

For the first time in the history of the United States Geological Survey's (USGS) oil exploration in the Arctic, no place is too distant, no site too remote to be reached by the telephone. Husky Oil NPR Operations, Incorporated has created a communications network that spans the 96,000 km^2 of the National Petroleum Reserve in Alaska (NPRA) to reach drilling rigs, geophysical CAT-train (tractor train) camps, logistics bases, airplanes, and rolligons. But the network does not stop there. The telephone enables today's exploration program to be coordinated from Husky and USGS offices outside the boundaries of the Reserve and even outside the State of Alaska.

The network is a multi-system approach to remote, long range communications. Many different organizations and companies have been called upon to design and construct a multitude of components for this system. Highly trained technicians keep the network running despite the rigours of the Arctic environment and the demands inherent in long distance communications.

Navy Commander John Reed, in his history of the Naval Petroleum Reserve No. 4 from 1944-53, observes that, "Communications were a serious problem during PET-4 and will be for any sizeable Arctic operation." During the Navy's initial petroleum exploration program on what was then known as NPR-4 or PET-4, direct voice communication to Fairbanks and all points south was non-existent. Messages were sent by telegraph through the Alaska Communications System (ACS) office in Barrow. Telegraph reception and service was sporadic at best. During the first six years of the program, from 1944-1950, messages could only be sent at scheduled times. In 1950, ACS extended its service throughout the working day. It could only be hoped that emergencies would not happen after five o'clock or on weekends.

In the first year of NPR-4 operations, barges carrying supplies for the Reserve headed north through the Bering Sea without benefit of communications to their points of destination. Barge captains had no idea what weather or ice conditions awaited them. Airplane pilots fared slightly better. Flight security communications during that first year were available, but only when ACS and Army Airways Communications System (AACS) personnel agreed to monitor point-to-point radios and navagational aids.

Some advances were made however. In 1950, Barrow established radio contact with several USGS field parties in the area. Radio links were also established between Umiat and field parties working in the eastern part of the Reserve. Hand-ringing telephones provided a communications link between the NPR-4 camp and Barrow village four miles away.

In 1957, four years after the close of the exploration program on PET-4, a relatively new communications technique called forward propagation tropospheric scatter using ultra-high frequencies (UHF) was being used by Distant Early Warning Sites located all across the Alaskan and Canadian Arctic. Troposcatter was discovered during World War II when it was learned that radio signals could be transmitted beyond the horizon by bouncing radio waves off the troposphere, the lower layer of the earth's atmosphere. Large transmitting and receiving antennas, aimed precisely at the next antenna, send and receive radio messages off the troposphere. These antenna also amplify a signal before sending it on to the next dish. Troposcatter has been used in remote parts of the world wherever the terrain is difficult and the weather severe. It provides reliable communications between DEW Line sites as far as 1100 km apart.

In the past, environmental conditions in the Arctic have made radio wave propagation difficult. Much of the Arctic is covered either by snow or ice for a good part of each year. Vast areas of the Reserve are underlain with permafrost which may reach depths of over 300 meters. In more temperate parts of the world, the earth acts as a natural conductor for low frequency radio waves, but frozen earth and ice cannot be relied upon for good conduction. Instead, ground conditions on the NPRA reduce or attenuate radio wave propagation. Today, special antennas are used to create an artificial ground.

Atmospheric conditions in polar regions further complicate communications. High frequency systems, which provide good communications over long distances in other parts of the world, are often interrupted in the Arctic by auroral activity and other ionospheric disturbances. High frequency radio waves travel great distances by bouncing off the ionosphere, an atmospheric layer above the troposphere, and returning to earth. If the ionosphere is disturbed by magnetic storms associated with the aurora, radio waves may not be reflected back to earth. During such events, they may fade or disappear altogether causing a black-out. Therefore, the same aurora that brightens the Arctic sky plagues Arctic communications. Today these atmospheric disturbances are at least predictable, and atmospheric forecasts can be obtained from the Higher Latitude Monitoring Station in Anchorage.

Combine these environmental phenomena with the great distances that must be spanned by the NPRA communications network and one can begin to understand the complexities of the communication problem. When Husky began exploration operations for the USGS in 1976, Teshekpuk Test Well No. 1 was being developed without reliable, direct voice communications between the well site and Camp Lonely, Husky's operational headquarters, only 25 miles away. Camp Lonely's earth satellite station was experiencing a variety of technical ailments and only worked part of the time. Regular contact with Husky's Anchorage office was made possible only by flying a Twin Otter aircraft from the Teshekpuk site to Deadhorse every day and calling in the daily report. Communications to points outside the Reserve had not improved significantly in over 20 years since the close-out of the earlier program, and communications within the Reserve were still a serious problem just as Commander Reed predicted.

The need for a back-up communication system in one of the most remote regions on earth became acute, and in 1977 a Transportable Repeater Network (TRN) was installed on the NPRA. This system was supposed to provide dependable VHF radio communications throughout the Reserve by using relatively self-sufficient repeaters located at various remote sites. Theoretically, these should only have to be refueled from time to time. Each TRN site was equipped with three transmitters and three receivers to accommodate a loop antenna configuration. Problems with the TRN system became apparent from the beginning. The installation of the repeaters ground to a halt when rolligons carrying the equipment bogged down in drifting snow. By April, when the network was finally installed, maintenance problems began cropping up. Generators, overloaded by the demands of too much equipment at each site, broke down. Exhaust vents in the repeater buildings clogged with blowing snow. By June, many of the repeaters had to be visited for repairs. It soon became obvious that the TRN's could not provide the back-up system for the NPRA communications and they were abandoned in December, 1977.

As the NPRA oil exploration program expanded, the need for reliable communications became critical and it was essential to develop systems and equipment that would work despite the severe Arctic environment. Under the direction of Mr. L. E. (Ed) Parsons, Husky's Senior Communications Engineer, a five component system was established:

1. Telephone communications to points outside the Reserve and outside the State.

2. Telephone and radio communications between Camp Lonely and all sites within the Reserve.

3. Air-to-ground radio communications to aircraft.

4. Intra-camp radio communications.

5. Back-up radio communications.

First, in order to establish some kind of communications to the sites already operating on the Reserve, the High Frequency (HF) Single Side Band (SSB) Radio System was upgraded. By the end of December, 1977, the same month the TRN was abandoned, SSB radios were carrying communications to almost every site on the NPRA.

Several months later, Trident Enterprises a SSB monitoring service, was hired to handle calls coming into the Anchorage office from the "Lower 48" after business hours. Whenever the switchboard at Husky's main office was turned to a night position, incoming calls were routed automatically to Trident. Trident, in turn, made all radio-telephone interconnects, routed calls, and logged all interconnections. Traditionally, such telephone-radio communication systems have served as life lines to Alaskan bush residents.

By May, 1978, a communications shop was established and running at Camp Lonely. It

provided a convenient place to repair and build communications equipment on site. A similar facility was set up in Anchorage where equipment could be modified, designed, and stored for future use. It was in the Anchorage shop that Mr. Parsons designed and built a local radio-telephone system that enabled Husky managers to keep in touch using portable units from their cars, their homes, or anywhere else in the Anchorage area. Such local repeater systems have become particularly useful to drilling foremen who can coordinate on-site operations by radio or telephone from wherever they are on the drilling pad.

Today, wherever Husky operates on the NPRA, the telephone has become an essential feature of that operation. Earlier radio communications generally transmitted factual or limited exchanges of information. But telephones offer better privacy, the opportunity for a natural two-way conversation, and ultimately a better exchange of information. During the winter, when cold and darkness take their toll on workers in the Arctic, the telephone provides a necessary link to the outside world. It can be the means to alleviate morale problems that could lead to work slowdowns. A telephone link to Husky office at Lonely, Anchorage, Cody, Wyoming, or the USGS in Menlo Park, California, enables construction and drilling priorities to be set from a larger vantage point than a single construction or drilling site. Decisions based on the overview from main offices can save time and money. Thanks to the telephone, each drilling site does not have to be a logistics site. Instead, Lonely can be maintained as a logistics headquarters and conveniently service exploratory sites.

In 1978, telephone communication demands on the NPRA were such that Husky decided to acquire two more earth stations for their drilling program. Early that year, two RCA Alascom air transportable satellite earth stations were installed at the Kugrua and Inigok test well sites. RCA Alascom had pioneered in the design and construction of these transportable earth stations. In addition, the Lonely earth station was relocated to a new pad in a less congested area. The new location permitted better antenna positions from which to signal the satellite. Once moved away from tanks and cargo storage, it was no longer plagued with outages and weak signals.

As drilling sites shift from season to season, so too must the communications facilities. Before airlifting the Kugrua earth station to the new Tunalik test well site in June, 1978, an airlift platform was designed and built at Camp Lonely. The helicopter airlift was accomplished without mishap, and RCA and Husky technicians worked together installing the station at its new site. During the 1978-79 construction season, two additional transportable earth stations were moved to the Seabee well site near Umiat and to the Lisburne test well location near the southern boundary of the Reserve. By the spring of 1979, Husky was using five satellite earth stations and an additional circuit off the Barrow commercial earth station. Satellite communication links extended telephone capabilities west to Tunalik, south to Lisburne, east to Seabee on the Colville River, and north to the Inigok well site and Camp Lonely. The following year these same earth stations were used, however two were moved from Tunalik and Inigok to new well site locations at Awuna and Koluktak. Telephone communication on the Reserve spanned over 1000 kilometers.

Additional back-up systems were necessary to support the large scope of exploration efforts on the NPRA. For those sites located along the western coast of the Reserve, such backup communications could be provided off the DEW Line tropospheric scatter system voice channel circuits, if they were available.

In August, 1977, Husky submitted a request to RCA Alascom to procure the circuits. In September RCA responded that they could not. Husky personnel contacted the DEW Line station at Barter Island and the Defense Communications Agency locally and at Scott Air Force Base. Through these contacts, available channels on the DEW Line system were determined and a letter was sent requesting their use. After this first request was turned down, Husky then rerouted a second request which was also turned down. On October 25, 1977, a letter of request written by Mr. Henry Coulter, Assistant Director, USGS, was hand carried to the Assistant Secretary of Defense in charge of Communications, Command and Control, and Intelligence. Things began to look better for Husky. On December 13, 1977, the Secretary of Defense informed the USGS that the requested DEW Line circuits would be made available for use by Husky on a non-interference basis. By January 4, 1978, Husky began installing the necessary interface equipment to make the Lonely PABX equipment compatible with the DEW Line facility at POW-1. As soon as these interface units were designed and installed, telephone communication using radio-telephone links was possible to sites over 300 kilometers southwest of Lonely. During 1978, DEW Line circuits served well site locations at South Meade, Kugrua, and Tunalik. The following year, the Peard well site was tied into the DEW Line system through its station at LIZ-3, via a VHF radio link. In addition, the DEW Line circuits increased telephone capabilities between Camp Lonely and the Husky offices at Barrow.

An alternative communications system for sites in the eastern part of the Reserve and in the foothills of the Brooks Mountain Range was established by upgrading the Long Haul Network. This is a system capable of spanning considerable distances by using repeaters at Cape Simpson, Oliktok Point (POW-2), Inigok Test Well No. 1, Knifeblade Ridge, and Lonely. These repeaters

transmit and receive both VHF and UHF signals. The resulting network provides "an instantaneous intercom" and is primarily used for aircraft support and weather reporting.

As exploration operations expanded on the Reserve, Husky became increasingly dependent on large aircraft for logistical support. The larger aircraft, in turn, required officially certified aeronautical navigation facilities at each airstrip. NPRA navigational communications facilities were upgraded to official status so that large aircraft would have optimum access to each site. Non-directional beacons had been used on the NPRA in the past; however, Husky was the first to have them certified by the FAA for Instrument Flight Rules (IFR) approach landings. The non-directional beacons had to be ground checked, radio checked, and flight checked for certification. Once again the Arctic environment posed a special problem to communications. Each non-directional beacon transmits a low frequency Morse code signal which identifies its location for aircraft or other vehicles equipped to receive the signal. In other areas of the world, this signal depends on a ground propagation system. To alleviate the ground attenuation problems in the Arctic, Husky technicians installed counterpoise antennas which act as artificial grounds. These antennas consist of radial systems of long wires attached to the bases of the vertical antennas just above the ground.

Logistically, the combined use of beacons, air-to-ground communications, and 24-hour weather reporting services means that large aircraft can maintain reliable support schedules to any Husky site on the NPRA. For the first time on the NPRA, official IFR systems are operating from nearly every corner of the Reserve.

Because of Husky's reliable communications network, all heavy aircraft traffic on the NPRA can be coordinated through the Anchorage office. Logistics control from one central office has many advantages. Weather reports, crew schedules, cargo, passengers, fuel supplies, mechanicals, and Electra and C-130 flight information are all transmitted over the phone. The telephone provides an overview of the entire operation so that needs can be anticipated and problems responded to immediately. Such efficiency means that Husky never has to fly an airplane empty.

Just as it is important for heavy aircraft traffic to be coordinated from Anchorage, light aircraft, such as Cessna-180's, Beavers, Twin Otters, and Aero-Commanders, must be coordinated from the Lonely Control Center (LCC) within the Reserve. The Camp Lonely logistics base was rebuilt near POW-1, a DEW Line Station located on the coast of the Beaufort Sea about 88 miles south-southeast of Barrow. From here, daily flight schedules are set up for small aircraft according to weather conditions and transportation requests from scientists, engineers, drilling and construction personnel, and official visitors. The day begins at Camp Lonely with passengers and pilots awaiting that first weather report over breakfast coffee.

On any given day over a dozen airplanes may be flying in support of exploration activities on the NPRA. Airport personnel use established flight following procedures to keep track of each airplane. Pilots must file flight plans before taking off. Airport managers keep manifests listing passengers, cargo, destination, take-off and estimated arrival times. This information is relayed through the Long Haul or the DEW Line networks, depending on location. If a plane is overdue or a problem occurs requiring air support, LCC can react quickly.

Weather is a primary logistical consideration in the Arctic. Until National Weather Service Stations were established at each drilling site, weather reports were regularly available from only two locations: Umiat, in the southeastern part of the Reserve, and Barrow, the northermost community in the United States. Two weather reports are hardly sufficient to cover an area of nearly 100,000 km^2, especially when high winds, blowing snow, fog, and severe cold constitute typical weather conditions. Any one of these conditions may restrict flying. For the first time on the NPRA, official weather reports are available every hour from as far west as Icy Cape, as far south as the southern boundary of the Reserve, east to the Colville River, and from several sites along the Arctic coast. Trained weather observers call in the temperature, sky conditions, wind velocities, altimeter readings, visibility, and precipitation readings from each site. Today, before airplanes take off from Fairbanks for the North Slope, the pilots have checked out weather conditions at their destinations.

Air-to-ground communications in the Arctic once consisted of dropping a message tucked inside a roll of toilet paper from an airplane. The real advantage to using the toilet paper roll instead of the traditional rock was that the paper would unravel on its way down and mark the landing spot. Today on the NPRA, air-to-ground capabilities may extend over 70 km. If rolligons or CAT trains travel out of range of the communication network, airplanes schedule flights over these ground vehicles and communicate using VHF unicom type radios. However, this vastly improved air-to-ground method is not often necessary on the Reserve because the regular communications network is so far reaching.

A large amount of bulk cargo for the NPRA is still barged to coastal logistics sites on the Reserve. However, today's barge captains have a good idea what ice and weather conditions they'll encounter before they enter the Bering Sea. Approximately 16 million liters of fuel

and 11 thousand tons of dry cargo are shipped north each year through the waters of the Bering, Chukchi, and Beaufort Seas.

Until very recently, Commander Reed's observation was true. Today, however, Husky has solved the communications problems in the Arctic. The Husky communications network plays a key role in the successful management of a major exploration program in one of the most demanding environments on earth.

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Social Aspects

THE BENEFITS OF SATELLITE TELECOMMUNICATIONS IN ALASKA

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Abstract

The introduction of satellite telecommunications in rural villages in Alaska has helped promote rural development when acting in concert with other socio-economic changes. This aritcle explores some of the apparent socio-economic changes which may be attributed to the rural satellite system, and some of the differences in value placed on the telephone by residents in various types of villages.

INTRODUCTION

The locational problems of Alaskan rural development are well known. Alaska's population centers are widely separated, generally lack land transportation, and are often further isolated by climate. This rural isolation has traditionally been one of the most difficult impediments to socio-economic development. The isolation from market centers and larger urban centers often means isolation from educational opportunities, health and other social services, information about market and prices, new means of production, sources of credit, and other types of information critical to economic growth.

Among development planners, transportation has generally been looked to as the primary means of ending rural isolation. Opening roads allows goods to flow to market, and allows information to flow between metropolitan and rural centers. However, in Alaska many rural areas remain outside of relatively inexpensive transportation systems because of distance, climate, and travel costs.

It is with the introduction of telecommunications that a major means of ending rural isolation has arisen. Satellite telecommunications in particular provides a cost-effective means of rapidly providing a broad range of communications services to widely separated communities like those in Alaska. While telecommunications cannot move goods to markets, it expedites the flows of information which can support development, and which impede development in their absence. It is not this article's contention that the introduction of satellite telecommunications in Alaska was solely responsible for rural economic development. Rather, the introduction of satellite telecommunications, combined with other social and economic events in the state, including the Native Land Settlements and the construction of the Trans-Alaska Pipeline, promoted development in parts of the rural sector. The benefits and value of the telecommunications system are not equal in all communities, but rather vary according to the characteristics of each community.

APPARENT BENEFITS OF SATELLITE TELECOMMUNICATIONS IN BUSH COMMUNITIES

The introduction of satellite telephony in Alaska has produced a range of social effects. There have been various attempts to isolate how the introduction of telecommunications can effect social change. Hudson and Parker (1), for example, have noted that the introduction of telephone service in rural health centers has improved the quality of health care. Further, Katzman (2) and Hudson (3) have noted that an increase in the use of one medium generally leads to increases in the use of others. Hudson has noted, for example, that telephony is generally looked upon in the Artic as a substitute for expensive and dangerous air travel. However, she found that the introduction of telephones tended to increase air travel due to the stimulation of other economic activities.

The clearest economic effect of telephony would appear to be on costs of economic transactions. Such costs are incurred to actually fulfill a social or economic exchange. These costs include opportunity costs (i.e., value of the time if it were put to a more profitable use), salary costs, transportation costs, overhead costs, and other, similar costs. Telephone, through its widespread network and instantaneous connections, can lower transactions costs, whish in turn can stimulate further economic activity. For example, by substituting communications for face-to-face meetings, considerable savings may be achieved in salary and transportation costs. Generally, the greater the number of people who can be reached on a network, the greater the overall value of the network to the subscribers (4,5).

Some changes have been noted in social/economic life in communities in Alaska that have either received telecommunications for the first time or have had telecommunications service of such inferior quality that improvement in service was similar to receiving telecommunications for the first time. These changes will be measured neither by the tariffs charged nor by the profits earned by the telephone carrier.

The ATS-1 satellite demonstration project in Alaska first indicated the impact that improved telecommunications could have on health and education. The ATS-1, an audio-only satellite, was inaugurated in Alaska in 1971 with 25 satellite earth stations. Each of the 25 sites had a receiver/transmitter located in a readily accessible location such as a community hall. The project had two major programs--to connect remote health clinics with regional and larger urban hospitals, and to improve education in the bush (6).

The Public Health Service, which ran the health project, concentrated its efforts in the Tanana Region of Alaska. This region covers a large part of interior Alaska and has the worst communication in the state due to severe atmospheric problems which restrict radio transmission. This health program allowed, for the first time, reliable communications among the Public Health Service's community health clinics, which are staffed by health aides, and hospital staffs (doctors and nurses). Thus, while one health aide conferred with a doctor about a specific case, health aides in other locations could pick up information about similar cases. This party-line aspect of the service was so impressive that the Public Health Service included it in the new PHS satellite system which is part of the Alascom/State of Alaska program discussed below.

The education-related activities were essentially of two types--educational and administrative. The educational program, aimed at schools and communities, had mixed success due to problems of programming and community organization. However, the administrative part, which provided reliable two-way communications, was very successful. The "Report on Alaskan Use of the ATS-1 Satellite Through September 30, 1972" noted that:

> In the past, generator failures, furnace blow-outs, or deficiencies in instructional materials would cause the whole school to shut down while a written message was mailed out. With the satellite radio, teaching conditions were greatly improved and teachers would call for immediate emergency parts during the critical winter months. The communications links between the schools and the area administration supported and encouraged the efficient operations of the schools (7).

The ATS-1 was followed in 1974 by the ATS-6, which provided video services (and used the ATS-1 for audio) and was used for a series of health and educational programs. Video transmissions went from rural clinics to central hospitals for diagnoses and discussion of treatments for individual patients. Also, lectures and interactive discussions were conducted for consumer education and continuing education for the health aides. The educational program included the production of a series of educational programs by station KUAC at the University of Alaska/Fairbanks for transmission to the various participating villages.

While the ATS-6 Demonstration Project was successful in showing that video transmission via satellite could be used both to improve the quality of health care to remote villages and for the diffusion of educational programs, it was generally less useful than the ATS-1 program because video, when purchased through commercial rather than government facilities, is relatively expensive. Nevertheless, these two programs clearly indicated the major benefits that could be achieved in terms of social services through telecommunications.

The subsequent installation of commercial satellite earth stations by the state of Alaska and Alascom has extended communications throughout rural Alaska. While there is a lack of any substantive data on the impact of this extended communication system, some limited information exists.

Improved communications has made certain froms of travel, often hazardous and expensive in the Alaska bush, unnecessary. Such transportation, which is pruely substitutable by communication (8), will be replaced as the satellite earth stations become fully operational.

Alaska provides a useful example of the effects of the introduction of telephone communications. Atka is a native village of approximately 90 people located on an island in the Aleutian Chain east of Adak. The inhabitants subsist generally by fishing and have limited employment generated by a Coast Guard docking facility. The community has no airstrip. Prior to installation of a satellite earth station, communication with the outside took place via the monthly mail barge from Adak. Such slow communication made applications for government grants-in-aid virtually impossible--the turnaround time between the Anchorage attorneys and the village was too long for timely application. Further, business trips by members of the village to Anchorage for meetings at the Native Corporation cost $900 per person just for per diem expenses for the month spent in Anchorage waiting for the mail barge to return to Atka.

With the satellite earth station, daily transactions at the Anchorage office at the Aleut League, which represents the Aleuts in most of their government dealings, have helped generate an increase in government grants-in-aid programs for Atka. The turnaround time for communications has been reduced from a minimum of one month to a few minutes. Also, instantaneous communications has permitted more timely ordering of supplies, educational materials, and health goods, which come on the mail barge.

The increase in activity in Atka has also been accompanied by a demand by the villagers for a landing strip so that travel need no longer be dependent on the mail barge (9).

There is other evidence that telecommunications changes the conduct of business. Interviews in the communities of Shishmareff, Teller, King Salmon, King Cove, and Unalaska have indicated that improved or new telephone service has improved the abil-

ity of retail businesses to contact suppliers and customers. Also, guide services have found it easier to contact clients to make arrangements, thereby increasing the amount of business.

An example of how improved communications affects business is provided by the Vita packing plant in Unalaska (10). Due to extreme congestion on the two Alascom VHF circuits feeding into Unalaska until November 1976, telephones could not be used for frequent contacts with the rest of the world. As a result, the Vita packing plant, which packs fish and crab for shipment to Seattle, operated as an atonomous plant. Its contacts with Seattle were primarily reports on shipments. Even this was unreliable, as bad weather often hindered the shipment of the mail. Shipments were made to Seattle in the hope that they would match demand.

The introduction of the satellite earth station eliminated the circuit congestion, and the Unalaska plant now maintians daily contact with its Seattle headquarters. As a result, the plant is more responsive to customer demand--an order placed in Seattle can be conveyed instantly to Unalaska and acted upon. Also, if prices in New York for a particular product increase, then Unalaska can change its fishing operations to take advantage of this information. This has resulted in improved efficiency, better customer relations as specific orders are filled, and a shift in managerial control making the Unalaska plant a satellite plant, rather than an autonomous one.

Introducing telephone service has improved the quality of life and changed the style of life in the villages. The existence of private line and MTS circuits to the villages has allowed the continuation of regular consultations between village health aides and medical centers intitated during the ATS-1 project. It has also allowed village residents easier contact with those providing medical services. For example, the amount of time women on the Aleutian Chain must spend in Anchorage receiving pre- and post-natal care has been reduced from two months to one month--women remain with their families longer and consult with the Anchorage Native Hospital by telephone (11).

The existence of toll service also allows continued contacts among native families dispersed due to exigencies of boarding schools, employment, health, and the like. This extended contact with families and friends provides a constant flow of information about urban life to the villages, much as the introduction of media has in other traditional societies (12). The introduction of exchange telephone service has also had beneficial effects on village life. For example, during the winter, telephones make it easeir to transact business and to make special contacts to determine where people are and whether hunting parties have returned.

INFERRED VALUE OF TELEPHONE SERVICE TO ALASKAN RURAL COMMUNITIES

Aside from the apparent benefits of rural telecommunications, one may infer the value of rural telephone by comparing calling patterns among population areas. One may infer that a higher incidence of calling (i.e., number of toll calls per capita) in community A than in community B indicates that the residents in the former value the telephone communication more than the latter (13).

In examining the Alaskan toll calling data for one month in 1977, one finds that, in general, the average incidence of toll calling is greater for villages with populations between 300 and 1,000 residents than for population centers of other sizes. This tendency does not strictly follow population size (i.e., it is not the case that the smaller the village, the greater the calling incidence). This tendency, which requires far greater cross-sectional and longitudinal study, seems to indicate that telephone calling is more important in medium (in the Alaskan context) than in large or small population centers. One may hypothesize that larger population centers have ready substitutes for toll calling. Metropolitan centers' communication in matters of commerce and social needs (e.g., medical, educational, familial) may be served by calling within the city or by telephone substitutes (e.g., driving to a doctor's office). Small remote villages will generally have to call outside of their villages for virtually all social and business needs, as the parties to be contacted will be located in other areas--rural villages by their nature do not provide broad ranges of services, business, and the like. In the case of the large metropolitan areas, the call will be a local call (much less expensive than a toll call), while for the villages, the communications will be a toll call, a letter, an airplane trip, or may not occur at all due to the communications cost.

The lower-than-average calling incidence that appears to occur among the smallest Alaskan villages needs further examination, given the above. While the reasons for this relatively low incidence are not totally understood, one must assume that telephone calling will vary among types of communities. As business and other activities vary from community to community, it is probable that intensity will similarly vary; villages with a vibrant fishing industry will have a higher intensity of telephone traffic, due to the need for more frequent contacts with markets and the need for regular contacts with suppliers of goods and services arising from the greater financial prosperity, than will the villages that have basically subsistence economies. This is consistent with the previously stated hypothesis that telecommunications per se does not lead to development, but must act in concert with

other socio-economic factors to influence development. It is probable that the cheif benefits of satellite telecommunications may be to communities that have passed beyond subsistence to more varied and developed economies. One may hypothesize that the smallest Alskan communities have still not reached the level of economic development where the addition of telephone service is of economic use to the inhabitants. (It is also probable that income levels in the smallest villages may be too small to sustain heavy telephone calling.) However, this does not imply that the rural satellite telephone system does not assist the provision of social services. Clearly, the quality of health care and education in rural Alaska had been inhanced by the satellite system (cf. H. Hudson's contribution). Far more study is necessary, using more recent data reflecting the record of more than four years of rural telephone experience in Alaska, to determine the relations between telephone use and economic development.

Clearly, rural poverty does not end with new telecommunications services. Economic and social development will be tied to other activities which, as a group, must reach certain thresholds before telecommunications can act as more than a rudimentary development tool. While telecommunications may be used by the government to provide social services such as health and education more efficiently, it is the overall development of the public and private sectors that are of importance for planners. While it is clear that there is a need for far more study in Alaska of the ties between levels of community activity, income levels, indices of social development, and telecommunications use in order to determine more precisely how telecommunications affects social and economic development, there can be little doubt from the early data that telecommunications has provided significant benefits to the Alaskan bush.

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(7) Alaska Office of Telecommunications (Juneau, Alaska, 1973): 17.

(8) As we already noted from Hudson (ref. 3), improved communications will not necessarily lead to decreased rural transportation demand and may actually increase it.

(9) Interview with Ralph Amouk.

(10) Interview with Don Tucker.

(11) Interview with Dr. Martha Wilson.

(12) For a general review of the relation of communications and development, see F. Frey, "Communications and Development," in I. Pool, et al., Handbook of Communications (Chicago: Rand McNally, 1973), 337-461.

(13) This assumes that all other variables are held constant. In fact, if the cost of using telecommunications differs among the communities being compared, then the value of the service will vary according to the tariff charge. This study has not included tariffs in discussing the calue of calling.

MEDICAL COMMUNICATION IN RURAL ALASKA

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1. Abstract

This paper describes the satellite-based teleconferencing network used by the Public Health Service in Alaska for communication between villages and regional hospitals, and to the Alaska Native Medical Center in Anchorage. The Alaskan experience using ATS-1 is summarized to show the model on which the operational system was based. Cost/benefit data emphasizing travel substitution are presented. Other potential applications of the satellite network are discussed.

2. THE HEALTH CARE ENVIRONMENT

The resident population of Alaska is about 400,000 of whom about 60,000 are Indians, Eskimos, and Aleuts. Most of this native population lives in widely scattered villages of 25 to 500 people. The average distance between one settlement and another is approximately 60 miles; some villages are more than 150 miles from their nearest neighbor. Village housing is typically without electricity, running water, or sewage systems. Rural unemployment is high, and welfare support prevalent. Much energy is spent in adapting to the rigors of the environment, which makes conventional means of communication and transportation difficult and unreliable. Travel between remote communities is primarily by bush plane. Storms, extreme cold, and rough, unlighted airstrips make flying hazardous and at times impossible. These factors compound the difficulties of providing health services to native Alaskans in isolated communities.

3. THE HEALTH CARE DELIVERY SYSTEM

Prior to the mid-1980's, traditional medicine as practiced among the native people was the mainstay of their health care. After the Alaska purchase, such non-traditional health care as was available was provided by the Public Health Service physicians assigned to revenue cutters that patrolled the Bering Sea. In 1931, the U.S. Bureau of Indian Affairs (BIA) assumed the responsibility of education, economic development, and welfare for the Alaska natives. Public health nursing services to natives were provided by itinerant BIA nurses associated with the BIA hospitals located throughout the territory. In 1955, the U.S. Public Health Service (USPHS) Division of Indian Health (later named Indian Health Service), assumed responsibility for health care of Alaskan natives.

The PHS facilities in Alaska are administered by the Alaskan Area Native Health Services, a part of the Indian Health Service. Administratively, Alaska is divided into seven service units, each with a regional hospital. Approximately 80 physicians work at these hospitals and outpatient facilities are staffed by commissioned officers or civil service employees of the PHS. The Alaska Native Medical Center, the hospital for the Anchorage region, is also the major referral hospital for the State.

Primary health care in the villages is generally provided by native health aides who are nominated by the village councils and employed by the regional native social service organizations using PHS funds. Basic training is provided by the PHS at the Alaska Native Medical Center. More advanced training is done in follow-up courses at Anchorage or on site in the villages.

The health aide returns to the village with basic tools: a drug kit, instruments, reference manual, and a communication link to the service unit hospital. Doctors at the service unit hospitals are expected to maintain daily contact with the village health aides in their regions.

Some larger villages are served by a registered nurse or other clinical personnel. Clinics have been constructed by some communities; in others, the clinic is located in the school or other public building. In many cases the health aide works out of his or her home.

About once per month nurses and/or doctors visit the villages to provide ambulatory care and preventive treatment. Specialists from Anchorage make regularly scheduled visits to the service unit hospitals and less frequent trips to the villages as required.

4. INTRODUCTION OF SATELLITE COMMUNICATION: The ATS-1 Experiment

In 1971, Alaska gained the opportunity to see if reliable communication would help to improve village health care. Twenty-six sites in Alaska were chosen to participate in an experiment in satellite communication using ATS-1, first in NASA's series of Applied Technology Satellites, launched in 1966.

Satellite communication via ATS-1 was first introduced into the Tanana Service Unit of central Alaska where two-way HF radio communication was notoriously poor because of problems of low reliability aggravated by long distances, the mountainous terrain of the Brooks range, and inaccessibility

of radios located in schools and teachers' homes. The central Alaska sites included nine villages without reliable communications, plus the hospital at Tanana, Fort Yukon (a village with telephone service), and the University of Alaska near Fairbanks. Earth stations were also installed at the other service unit hospitals, the Alaska Native Medical Center in Anchorage, and St. Paul in the Pribilof Islands. Earth stations at hospitals which did not use the satellite frequently were later moved to other villages in the Tanana Service Unit. By the fall of 1974, the number of sites in the Tanana Service Unit had increased from 12 to 17.

The impact of improved communication was dramatic: in the first year the number of days in which a health aide could contact a doctor increased more than five fold, and the number of patients treated with a doctor's advice more than tripled. (See Table 1.) It was also found that the shared channel had the advantage of enabling the health aides to listen to consultations between the physicians and other aides, thus improving and refreshing their knowledge. Listening in to other medical traffic also reduced the sense of isolation. The ability of the patient to hear the doctor helped to reinforce the health aide's advice. In addition, there was a potential for using the system for training in a "broadcast" mode.

5. THE PHS SATELLITE NETWORK

5.1 THE SYSTEM AND ITS APPLICATION

In 1975, the Alaska Legislature provided funds for the purchase of 120 small earth stations to provide telephone service to all communities with a permanent population of 25 or more.

The Public Health Service has leased a dedicated audio conferencing network consisting of five simplex channels for medical communication using the satellite facilities. The system design is based on experience with HF radio and later with ATS-1, where health aides and the hospital in the Tanana Service Unit shared a single audio channel. This conference circuit was found to have advantages for training and overcoming the remote health providers' sense of isolation.

These features were combined in the operational medical network. Two hospitals and their associated villages share each of four simplex channels. A fifth channel is dedicated to hospital to hospital communication only to ensure privacy.

The major types of medical traffic carried by the system are:

- Emergency calls: involve a patient who is seriously ill or who has suffered a significant accident. Such calls may be made at any time of the day or night and may interrupt regular medical traffic. An alarm at the hospital may be activated remotely by the village health aide.

- Routine medical traffic: is defined as consisting of calls which the health aide and the local regional hospital doctor conduct daily on the time and frequency assigned to discuss routine patient care.

- Administrative calls: on a scheduled basis, if possible, and are not to interfere with medical traffic. These calls may involve such things as ordering drugs and supplies, problems with the clinic building, questions on leave or salary, etc.

- Patient inquiries: involve routine calls about the status of a patient or messages about discharge plans, travel or important personal affairs. These calls are limited to the times set aside for this purpose by the regional (Service Unit) hospital.

"Doctor call" is the main service of the medical network. Each weekday, doctors at service unit hospitals contact the health aides at villages in their unit by satellite, in a format which originated with HF radio and was applied during the ATS-1 project.

Each of the participating health aides has a "satellite phone" in his or her home or clinic. Every day the doctor at the hospital calls each health aide in turn on the single "party-line" circuit. The aide may ask the doctor for specific instructions after describing signs and symptoms, or may simply seek verification of their own diagnosis and treatment plan. The medical facilities in the village are still very limited, so that seriously ill patients must be evacuated. The satellite radio can be used to arrange for evacuation of patients, usually to a service unit hospital. The "doctor call" is conducted daily in each service unit according to the following schedule:

Frequency #1 - Anchorage and Kodiak 9:00 AM and 11:00 AM
#2 - Kanakanak 11:00AM, Bethel 1:00 PM
#3 - Nome 1:00 PM, Kotzebue 3:30 PM
#4 - Barrow 10:00 AM or 11:00 AM, Tanana 1:00 PM or 3:00 PM
#5 - Frequency is available for inter-hospital communication only. This button is not functional on a village handset.

Health aides have been uniformly enthusiastic about the satellite network. The health aide in Tununak stated: "The medical telephone works much better than the radio. Sometimes the radio had such static you couldn't hear what the doctor was saying. When you call on the radio, people do not answer right away. With the telephone, they pick it right up."

Daily communication with doctors reinforces the health aides' confidence and gives them a sense of security. The health aide in Atka, the westernmost civilian community in the Aleutian Islands, more than 1,100 miles from Anchorage, stated: "I feel so much better knowing that a doctor is always

there to help me. When I have an emergency I just call the doctor and he tells me what to do." Previously, she had to communicate by HF radio to a U.S. naval station at Adak but now she can communicate instantly with the Alaska Native Medical Center in Anchorage.

Perhaps the best summary of importance of the satellite link to a village health aide was given by the health aide for Huslia, an Athabaskan Indian community on the Yukon River, who has been using the satellite link since the beginning of the ATS-1 network in 1971: "I use the satellite radio every, every, every day."

5.2 BENEFITS AND COSTS OF THE SATELLITE MEDICAL NETWORK

The advent of the commerical satellite service with the dedicated medical network modelled on the ATS-1 system has brought the advice of a doctor to every village on a daily basis, and provided a 24-hour emergency link to hospitals. Impact on mortality and morbidity will take years to become evident, and is complicated by many other socioeconomic and environmental factors. However, the availability of emergency medical communication has clearly helped to save lives, and the regular doctor call and administrative communication features have resulted in more village Alaskans being treated with a doctor's advice, a higher standard of performance by health aides, daily reinforcement and upgrading of their skills, and more efficiently managed health care delivery system.

The cost of this service, now provided by the state's long distance carrier, is substantial. The service costs $875 per village per month and $160 per hospital (hospitals are located in larger centers with exchanges and several trunk circuits). The charges are based on the proportion of the total traffic per site carried by the dedicated network. Assuming a village health aide uses the system an average of 25 days per month, this works out to a cost of $35 per day for each village. Total annual system cost now amounts to $875,100. (See Table 2.)

However, the vast distances and difficult terrain make the cost of transportation very high in Alaska, so that the communication system becomes an attractive alternative as a substitute for transportation alone. Table 3 shows the cost of air service from various locations in Alaska to Anchorage. The most striking example of the benefit of communication substitution for transportation is St. Paul in the Pribilof Islands which maintains a daily schedule with Anchorage Native Medical Center, which is its closest referral hospital (1,000 miles away). Roundtrip airfare from St. Paul to Anchorage is $643.

Table 4 shows the typical costs of air transportation within a service unit. Average airfare for a roundtrip from a village in Northwest Alaska to the hospital in Kotzebue is $97. Consultations with the doctor by satellite which make possible the treating of patients in the village rather than transferring them to the hospital will save both transportation and hospitalization costs that amount to a minimum of $500 per patient, and may cost several thousand dollars. The ability to coordinate rural services, order drugs, arrange field trips, etc. improves the efficiency of the health care delivery system and the morale of the village worker.

5.3 OTHER POTENTIAL APPLICATIONS OF THE SYSTEM

To take maximum advantage of the investment in telecommunication, other services could be offered. The Public Health Service now has a computerized health information system of records for each patient which are updated after each patient contact. This system has major advantages on improving accuracy of medical history for members of a mobile population who may seek treatment in the city or in regional centers as well as in their home community. The computerized medical record system also facilitates monitoring of high risk groups such as patients with pacemakers or with histories of tuberculosis or rheumatic fever. Field nurses can also take up-to-date lists with them to the villages of children requiring immunizations, women due for PAP smears, etc.

These records are currently kept on microfiche in the field so that a current record is available wherever the patient appears in the health care system. However, it would be more efficient to make these records accessible and updatable from each regional hospital using computer terminal links via satellite to the database.

The Public Health Service is also interested in using the narrowband channel for other applications, including electrocardiograms (EKGs), heart sounds with an electronic stethoscope, and slowscan video for transmission of X-rays and pictures of lesions wounds, etc.. These applications were tested during the ATS-6 demonstrations in 1975, and appeared to be most appropriate for communications between a field hospital and a major medical center. The voice link is generally all that is required at the village level, because complicated or severe cases must still be evacuated as facilities in the villages are very limited.

The satellite network could also be used more extensively for training. Pilot courses were tested successfully during the ATS-1 experiments. The flexibility of the audio network makes it possible for a lecture or seminar to be originated from any point. The system can be configured to serve special interests -- for example, all nurses involved in cardiac care or all health aides interested in learning more about treatment of otitis media could turn to one of the four channels at a predetermined time. The network could also be used for community health education if groups such as prenatal women, mothers of small children, teachers, etc. were asked to meet at the village clinic to participate in sessions held over the conference network.

These applications require planning and organiza-

tion. The PHS would have to commit additional staff resources to derive maximum benefit from its unique satellite medical network. It would appear that then additional benefits would more than justify the investment.

TABLE 1

Days of Radio Contact with Doctor Before and After Installation of ATS-1 Satellite Ground Station

Villages	BEFORE		AFTER			
	1970-1971		1971-1972		1972-1973*	
	average number of days	% of poss. days	average number of days	% of poss. days	average number of days	% of poss. days
ATS-1 villages (9)	51.7	14.0	270.2	74.0	310.0	85.0
Control villages (4)	44.0	12.0	24.3	7.0	N/A	N/A

SOURCE: Kreimer et al., 1974.

TABLE 2

Lease Charges for Alaska Public Health Service Medical Network as of September 1, 1981:

75 villages @ $875/month	$ 65,625
10 hospitals @ $160/month	1,600
National Library of Medicine (Maryland)	2,700
Transponder lease: 5 circuits	2,500
Miscellaneous local loops	500
	$ 72,925 per month
	or
	$875,100 per year

TABLE 3

Airfares Between Anchorage and Selected Points

Anchorage*	-	Adak	$ 686
		Aniak	230
		Barrow*	356
		Bethel*	190
		Dillingham (Kanakanak)*	184
		Fairbanks	160
		Galena	210
		Juneau	266
		Ketchikan	346
		King Cove	508
		Kodiak*	150
		Kotzebue*	304
		Nome*	304
		St. Marys	254
		St. Paul	643
		Shemya	925
		Sitka (Mt. Edgecumbe)*	264
		Tanana*	230
		Unalakleet	242
		Wrangell	314
		Yakutat	176

*Service Unit Hospitals

TABLE 4

Roundtrip Airfares within an Alaskan Public Health Service Unit

Kotzebue	-	Ambler	$ 118
		Buckland	78
		Deering	78
		Kiana	78
		Kivalina	96
		Kobuk	130
		Noatak	78
		Norvik	68
		Pt. Hope	130
		Selawik	82
		Shishmaref	110
		Shungnak	118
		Average:	$ 97

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Microcomputer Instruction in Remote Villages in Alaska[1]

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Abstract

In 1977 the State of Alaska embarked upon a project to apply space age technology to problems of educating students in remote and isolated villages in the state. The project is jointly funded by the National Institute of Education and the State of Alaska. One outcome of this project is a microcomputer based instruction system for high school students in the small schools located in a number of Alaskan villages. The students, mostly native Americans, have available coursework in greater variety and of better quality than the small number of teachers at village schools could otherwise provide.

INTRODUCTION AND CONTENT

Design for a microcomputer-based instruction system for rural secondary students began in 1978 with a consideration of a worst case school setting. Imagine, if you will, twenty children of ages 5 - 18 comprising the student population of a small school in an isolated community with a total population of 75. Many, if not most, of the students are from a native American population with a relatively brief history of education in a school setting. The students are from homes where one of a number of native languages is spoken, where the educational level of the parents is relatively low, and where the educational objectives of more standard American education are not necessarily valued. Many of the students have a history of poor academic performance and have a rather negative view of schools and schooling.

The communities in which these schools are located are small, separated by many miles from neighboring villages, and often accessible only by small boats or airplanes. During a number of weeks each year, due to weather and climatic conditions the communities are inaccessible. Often there is a single village phone, placed there primarily for emergency medical use. Long periods of darkness and extreme cold magnify the perception of isolation experienced by the residents of the communities.

The teachers at this school are typically from another state, traditionally trained, and marginally equipped by training or experience to deal with the situation confronting them. They are likely to remain at the school for only a year or two. Teacher turnover is high and program disruption is typical rather than the exception. The teachers are looked upon as outsiders. They face difficult and unaccustomed living conditions where a lack of running water, modern plumbing and heating, and shopping facilities is the norm. On the positive side they tend to be young, dedicated, and energetic persons. But they are faced with long hours of work involving responsibilities that run the gamut from building and power plant maintenance to administering and offering a complete K-12 educational program.

The problems are especially critical at the secondary school level where there is a necessity to simultaneously offer a full complement of courses across a broad spectrum of content areas. The design problem we faced was to implement a technologically based system of instruction which would allow small isolated schools to offer a variety of high quality courses at the secondary school level without a corresponding increase in staff size and without the necessity to transport students to schools in larger population centers.

THE LARGER CONTEXT

The overall implementation of the microcomputer instruction project was required to fit into the larger context of education in the state of Alaska.

Alaska is the largest state in the United States and covers a land area equal to about 20% of the remaining 49 states. The state is physically separated from the contiguous 48 states. It is characterized by rugged terrain, extremes of climate, low population density, a limited land transportation system, and many small isolated communities with access only by sea or air. The state has a population of 400,000 and of these 50,000 are native Americans who belong to seven major culture and language groups. Major factors in the economy of the state are state and federal government spending and the recovery of natural resources (timber, fish, minerals).

The state is in a rapid period of transition and socioeconomic disruption. Most notable is the sudden impact of massive wealth derived from petroleum. This is occurring in an economic system with little economic infrastructure. Most employment is dependent on government spending or the harvesting of natural resourses. For large numbers of people there is simply no viable economic base. Yet the state is committed to a program of modernization including major investments in hydroelectric development,

transportation, and communications. There is considerable social and political support for the development of computer technologies and a modern broad and narrow-band satellite-based telecommunications system. There is a perception that the state may be able to leapfrog several generations of technology and there appears to be a political commitment to do just that.

The vast majority of K-12 students attend public schools in 52 districts funded mostly by the state of Alaska through the Department of Education, but largely controlled by local boards of education. Schools exist in almost every Alaskan community irrespective of size. School buildings are modern and well equipped, but school staffs are typically small and the number of students per school is low. Many schools have less than 30 students across all grades and three or fewer teachers.

SYSTEM DESIGN AND IMPLEMENTATION

A. Problem Statement

The problem was to design a technologically based system of instruction for rural secondary students that would increase the quantity and quality of course offerings and help alleviate the discontinuity in program caused by teacher turnover.

B. Conditions

The following conditions were taken into account in the design process.

1. Teacher time available for individual secondary level courses is minimal.
2. Teachers cannot be expected to be expert in all subject areas needed for a secondary program.
3. Students are part of a larger multi-age group working somewhat independently on various levels and in various subject areas.
4. The educational support system outside the school is often not readily accessible.
5. Students are typically reading and performing below the level expected in larger urban schools.
6. Local social and cultural factors may not be supportive of traditional education values.
7. Factors such as electrical power fluctuations and poor communications need to be taken into account in the design.

C. Assumptions

It was assumed that the following factors applied to the situation.

1. Technology itself was culturally insensitive. That is, from our past experience in Alaska we knew of no cultural barriers to the implementation of technology in education.
2. Delivery of the major portions course content via communications was not technically feasible until such time as significant communications systems development occurred.
3. Based on our knowledge of the learning process and the availability of teacher time a high degree of the interactive portion of student learning needed to be accomplished via technology.
4. Entire course packages were needed rather than enhancements to ongoing courses already offered at the schools.
5. The course packages needed to be entirely self contained and not dependent on distribution at critical points in the instructional process.
6. Teachers would have to provide equipment maintenance, as well as operate, any projected instructional system due to isolation and transportation problems.
7. Problems with fluctuating electrical power needed to be solved.

D. Design Components

The design process addressed the following rather standard components.

1. Specification of objectives
2. Strategy for development of materials
3. Selection of technological approach and specific equipment
4. Strategy for systems implementation, training, and maintenance
5. Specification of a strategy for pilot testing and formative evaluation
6. Consumer involvement
7. Finance
8. Systems Management
9. Policy implications

E. The System Design

The following is a brief summary of the system that resulted from a consideration of these components. In this summary attention is given to most of the design components listed above.

The design objective was to develop and implement a system of technologically based instruction that would increase both the quality and quantity of course offerings in rural secondary schools in Alaska. Based on a series of state-of-the-art studies commissioned by the department it was determined that neither the required system nor existent software component from which to build such a system were available. However, the core printed materials upon which to base the needed courses were found to exist. The decision was made to utilize such products as textbooks and correspondence study packages in the course development process in order to keep development costs within an affordable range.

The instructional system that resulted combined three basic technologies, the microcomputer, instructional audio tapes, and printed materials. The system was named Individualized Study by Technology (IST) and is described in more detail in publications available from the authors. The IST system empahsizes individual student learning and capitalizes on the microcomputer to provide a high degree of interactive learning time for students. Further, it took advantage of the capability of the microcomputer to perform the rather elaborate scheduling and record keeping functions needed for a system that allowed for individual pacing for a number of students across a variety of courses. Printed materials are utilized for content delivery and instruction. These are supported by explanations on audio tapes and vocabulary drills on the computer. These two components, coupled with a carefully selected readability level for the materials, allowed us to compensate for limited reading skills and to provide instruction through alternative sensory modalities.

The system components and the courseware were developed under contract to the department by the Northwest Regional Educational Laboratory in Portland, Oregon. The decision was made early in the project to avoid creating a large staff of specialists in the department for product development, but to gradually increase staff capacity to provide assistance with systems implementation and maintenance. This decision was a good one. We have been able to provide a high level of continuing assistance to schools utilizing the system and to retain the flexibility to capitalize on new technological developments as these become available.

The system was designed to be self contained. That is, all materials are delivered to the classroom ahead of time and the equipment operates independently of a communications system or large main-frame computer at another location. The microcomputer chosen for the system is a 48K Apple II and all programming needed for the system is contained on five inch floppy diskettes.

Concurrent with the process of designing the instructional system, a design was developed for the sub-systems of training and maintenance. We feel that the weakness of many systems is the lack of attention paid to critically important support functions. We correctly anticipated that the costs for these three items would easily rival those for systems development.

Pilot testing began on a small scale in the spring of 1979. The system was field tested in seven communities 1979-80 and in thirty communities in 1980-81. The results of these tests have allowed us to make minor revisions and have encouraged us to utilize the system in 80 communities this fall.

Broad consumer involvement has been sought throughout the design process and in course selection and implementation. Beginning with the 1980-1981 school year we have insisted that local school districts pay the costs of equipment, materials, and teacher travel to training workshops. At this point in time school districts must invest their own money to utilize the system. They select only those courses they wish to use. This has resulted in a greater feeling of ownership, has not lessened the demand for the courses, and has led to a more serious effort at local implementation. Financing for the design, development, training and support components of the project continues to be provided by the state.

Critical to implementation of the system has been the need for teacher training and field support. Our current training system is based on two years of refinement and an overview is attached to this paper. We have found that teachers, totally unfamiliar with the system or the equipment used, can be trained to implement the system in the classroom in three days of intensive training. The training includes particular attention to simple maintenance and repair of the microcomputers, since to ship the equipment to a distant repair point can interrupt or inhibit the instructional process.

To say that the training is entirely adequate for the maintenance of the instructional system in the classroom, however, would be incorrect. Periodic advice and assistance with problems has

been needed. In the past this has meant department staff time assigned travel to schools and to provide assistance by phone. Our current plan calls for continued availability by telephone and bi-weekly audio teleconferences in which problems and issues can be discussed on a regional or statewide basis. We are also attempting to identify and train members of the district staff to support the system at a district level.

SYSTEMS MANAGEMENT AND POLICY

The Department of Education is one of 16 departments of state government is Alaska. Budget planning and policy involves both the State Board of Education and the Governor. Any budget documents resulting from this planning effort must gain the approval of a variety of legislative committees and the State Legislature as a whole. Because the initiation of the project involved a sharing of the 6 million dollar cost with the National Institute of Education, national policy had to be taken into consideration. Finally, and perhaps most important, there were the unwritten policies of educational politics involving teacher unions, the organizations for local administrators, and the organization of local boards of education. These groups play an extremely active, while not entirely visible, role in educational decision making in Alaska. The point being that the genesis of the project occurred in a content which is complex and often contentious.

The result of all this was a policy and management problem that is fairly common when one is considering change, technological or otherwise. We feel in the beginning the design must attempt to accommodate the policies of others. If successful in this effort, the communication from management to other than project staff should then be customized to the specific policy concerns of those who have the power, derived or assigned, to significantly effect the potential for success or failure. This we did and it resulted in several management and policy decisions which had a direct effect on the design of the project. Several examples may serve to illustrate. We determined that the system should enhance or supplement the capacities of existing teachers and not supplant or attempt to replace them. As another example, we knew that local boards, their administrators, and teachers would be concerned about the imposition of unwelcome curriculum. Therefore, for very practical reasons, we extended to the user the power and authority to select the course of study to be developed; even when in our opinion they were not making the best choice. Although one seldom encounters it in quite this fashion in the literature, there is no doubt that many of the principles of marketing are as important in the success of educational change strategies as they are in the world of business.

It has been our experience that one must have two separate, but related, management and policy concerns. Attention must be paid to both or project success is jeopardized. The first of these, as has been briefly described, is that of the political and policy relationships with others. While that is a truism to the point of triteness, we seldom find educators in our area of the world actually managing this process on the basis of formal planning and design decisions.

The other more traditional management and policy concern is known to many practiced in areas of endeavor other than education with great skill and expertise. This concern is that of systems development and product delivery. Because we do not pretend to be experts in this area, we will restrict our remarks to several observations we have made which appear to us to be of great importance.

We seriously doubt if it is possible to successfully develop and implement educational technology without using a team made up of individuals with varying types of expertise. This, however, creates a real problem for the project manager because he or she must become adept at identifying miscommunications between experts who use entirely different sets of technical and professional terms. Once the members of the team go about the business of developing their individual components to the system, any misunderstandings that exist become troublesome and expensive. We found that the following management practices to be both necessary and desirable.

1. Insure that all members of team understand that the relationship between the various components is iterative, i.e., the nature of a sub-system effects interfacing subsystems and the system as a whole.

2. Develop product specifications carefully and throughly before the initiation of work.

3. Document all decisions, especially changes, and develop clearly understood schedules.

4. Establish a rigorously maintained schedule of team meetings for the purposes of carefully reviewing current status in terms of product development and the relationship between products.

5. Do not permit the situation to develop where computer software developers are geographically isolated from your instructional designer.

6. Do not let the technology become the purpose of the project. That is, educational goals should be the primary focus.

SUMMARY

The focus of this paper has been on the design implementation of a technologically based system of instruction. The technical details of this system are not described herein, but are available upon request from the authors. Further in our narrative we focus on instructional technology (in general) rather than entirely on computers when discussing system design. This is consistent with the scope of our own efforts which includes broad and narrow-band communications and other specific technologies such as the videodisc.

We sincerely hope that what is presented here may be of some help to persons involved in instructional systems design elsewhere. We also welcome suggestions and comments others may have which would be of help to us in our continuing efforts to address educational problems in Alaska through technology.

1. This paper was originally presented at the Third World Conference on Computers in Education in Lausanne, Switzerland, July, 1981.

The learn/ALASKA Networks; Instructional Telecommunications in Alaska

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1. Abstract

In the last two and one-half years Alaskans have seen a remarkable process of educational collaboration evolve between the University of Alaska and the Alaska Department of Education in the arena of instructional telecommunications. This paper chronicles that evolution, the outcomes achieved to date, and projections of next steps.

2. RECENT ALASKAN TELECOMMUNICATIONS HISTORY

2.1 TELEVISION

From 1977-1981 the Alaska Department of Education aired up to five hours per day of network children's and family educational programming on the State of Alaska Television Demonstration Project (TVDP). In 1979-81 the University co-sponsored airing of several adult learning series; Sheldon Jackson Junior College was a co-sponsor of several of these offerings.

2.2 COMPUTER COMMUNICATION

Since 1976 the University of Alaska Computer Network (UACN) has offered an electronic mail service. This service is accessible to all University faculty, students and staff on all four year and community college campuses.

In 1979 the Alaska Department of Education, with support from the National Institute of Education, instituted an Electronic Mail System to link the administrative offices of Alaska's fifty-two school districts with administrative and support services of Alaska Department of Education, regional educational resource centers, the University of Alaska Teacher Placement Program and School of Education.

Concurrent with the Electronic Mail System implementation, a series of micro-computer based high school courses were developed by the Department, and introduced in a series of selected small rural high schools.

2.3 AUDIOCONFERENCING

Since 1978 the Legislative Affairs Agency has used a dedicated audioconference network to link legislators and their constituents for purposes of securing citizen participation in the state's legislative process. The Legislative Teleconference Network reaches 14 sites on a full-time basis, 5 teleconference sites, and 2 off-net sites (any Alaskan community can dial in on off-net). As capacity allows, other State funded entities are able to access the LTN.

3. EDUCATIONAL BACKGROUND

The University of Alaska is constitutionally mandated to provide public higher education in Alaska. The University has evolved from an original campus in Fairbanks established in 1917 to a statewide system of three four year and graduate level campuses (University of Alaska-Fairbanks, UA-Anchorage, UA-Juneau); and a Division of Community Colleges, Rural Education and Extension (CCREE) which encompasses ten community colleges, a division of rural education learning centers, and the statewide Cooperative Extension Service. As a Land-Grant institution, the University embraces a tripartite mission of instruction, public service and research.

The Alaska Department of Education is legislatively mandated to provide oversight to all public elementary and secondary education in the state. The Department also provides direct support of adult education and some forms of vocational education. Actual instruction is carried out by Alaska's fifty-two school districts.

In 1975, the State of Alaska committed itself to the construction and support of numerous small high schools in rural Alaska. Accordingly, a growing number of rural high schools are now in their first years of development.

4. LEGISLATIVE AND PLANNING BACKGROUND

In spring, 1979, the Alaska Legislature passed a resolution requesting the Alaska Department of Education and the Alaska Public Broadcasting Commissionto assess the feasibility of utilizing television for instruction on a statewide basis.[1] Ultimately the study was jointly conducted by the Department of Education and the University of Alaska, with limited financial support from the Commission. Issued in February, 1980, the study called for the development of comprehensive interactive telecommunications services to support life long learning in Alaska.[2] The study recommended: the establishment of strong inhouse faculty and teacher orientation in the effective utilization of telecommunications for learning; the establishment of production capability for the development

of Northern-based curricula; and that an early emphasis be placed on the regional and cultural distinctions which so enrich the lives of Alaskans.

Three telecommunications systems were specified; 1) a full-time instructional television service linking all permanent Alaskan communities, with multiple uplink sites at the major rural and urban centers of the state; 2) a separate instructional audioconferencing network; 3) the expansion of the University's computer network to the six community college communities which were unserved at that time. Emphasis was focused on the need for interactive systems which could be meshed in flexible configurations to support instructional planning, information exchange, and administrative use.

In June, 1980, HCSSB 165[3] was signed into law by Governor Jay Hammond. This legislation funded the three services identified above. The University of Alaska and the Department of Education were funded to establish limited production and teacher/faculty development capabilities. The Alaska Department of Transportation/Public Facilities was funded to install, operate, and maintain the new (audio and video) systems. In that year's telecommunications funding the Governor, in his letter of transmittal with HCSSB 165 made explicit his decision to curtail expansion of the State's entertainment television service (TVDP) and instead to strongly support the establishment of the new instructional telecommunications systems.

In September, 1980, the Commissioners of Education, and Transportation/Public Facilities, and the President of the University signed a joint memorandum establishing the basis for inter-agency planning and installation/maintenance of the new services.[4] In this document priority sites for new service were identified. Here the University of Alaska Instructional Telecommunications Consortium was specified as the manager and operator of the television and audioconferencing networks. Detailed planning would be conducted by the University and the Department of Education, with the University as the central liaison between the Alaskan educational community and the Division of Communications of the Department of Transportation/Public Facilities.

In April, 1981, the first of the two learn/ALASKA networks became a reality. Approximately 100 Audio Conferencing Site Coordinators were trained in two-day workshop sequences, held simultaneously in Anchorage and Fairbanks. Service began--

In June, 1981, the legislature funded, and the Governor approved the expansion of the learn/ALASKA television network to an additional 120 sites.[5] This, in addition to the 100+ sites already under installation, would assure a comprehensive level of coverage to all Alaskans.

5. learn/ALASKA TELECOMMUNICATIONS SYSTEMS

In September, 1981, the learn/ALASKA operations function neared completion. The original date for the start of a full level of television service was postponed due to three factors: FCC licensing delays; finalization of earth station construction; and extended programming rights negotiations.

At the time of this writing (November, 1981) status is as follows:

5.1 AUDIOCONFERENCING

There are now 99 learn/ALASKA audioconferencing sites in 61 Alaskan communities. Each site has been established under formal agreement between the local educational sponsor, the other educational users in participating communities, and learn/ALASKA. This agreement assures multi-user access to the site, and identifies the individuals who shall receive site coordinator training, thus becoming responsible for local access and appropriate utilization of the network.

To date, the audio network has used dial-up long distance phone service via Alascom, Alaska's long lines carrier. Calls are bridged together via four interconnected twenty line Darome conferencing bridges. Capacity allows up to 16 simultaneous conferences of five separate parties each. Scheduling for University of Alaska instructional use is made on a semester basis. Shorter scheduling frameworks are currently used by the Alaska Department of Education, and school districts. More occasional users book network time up to one week prior to a proposed conference. Local audioconference participation is coordinated by the Audio Site Coordinator. Each established site has access to one or more portable Darome conveners (model 624). A convener consists of a small

(18" x 8" x 6") speaker, and four microphones linked into the speaker. A single phone line jack is used to interface a phone and the convener. The learn/ALASKA audioconference network uses the same phone circuitry used by Alascom for all dial-up long distance traffic.

5.2 TELEVISION

The learn/ALASKA television system is satellite based. The UA Center for Instructional Telecommunications, the operations and production facility of the University of Alaska Instructional Telecommunications Consortium, serves as operations center for the learn/ALASKA networks. The Center is housed on the campus of the UA's Anchorage Community College. Access to satellite delivered program sources is via the network's nine-meter earth station, located in Eagle River Valley outside of Anchorage. Programming is currently accessed from SATCOM F1, and the earth station, which is steerable, is technically capable of accessing the Canadian ANIK series. Through agreements with the local public television station, the network also has receive capability from WESTAR. From Eagle River, programming is microwaved to the Center, and is then directly fed via microwave to the Alascom toll center for uplinking to SATCOM 2, Transponder 11, or is taped for delayed transmission. The learn/ALASKA system will shortly have uplink capability in Juneau, Fairbanks, and Kotzebue as well; once uplinked to Transponder 11, programming is received, via small (4.5 meter) earth stations. Local distribution is via low power ("mini") transmitters, under the new low power licenses recently established by the FCC. In instances where telephone and other telecommunications traffic is higher, programming is received via Alascom's mid-route earth stations.

We are now feeding several hours/day of programming in a test mode to 78 sites. As additional licensing is finalized, new receiver-transmitter installations completed at existing earth-stations, and new earth-station construction completed, the number of functioning sites will increase to over 100. Programming hours will be increasing immediately, with achievement of the full 18-hour day targeted for December.

The Division of Communications (now a part of the State Department of Administration) is now initiating licensing for the additional 120 sites authorized by the last Alaskan legislature. These sites will become operational in the next 18-24 months.

5.3 COMPUTING

The University of Alaska Computer Network (UACN) communications capability has now been extended to all of the University's community college sites. The UACN electronic mail service, and the Department of Education's comparable service are jointly used for the scheduling of audioconferences, and other specialized communication in support of the utilization of the learn/ALASKA networks. This semester a computer-conferenced course has been conducted on the UACN, involving 60 students from throughout the state.

6. UTILIZATION CONSIDERATIONS

6.1 "CLOSED" VERSUS "OPEN" SYSTEMS

The very public nature of the learn/ALASKA television system, as opposed to the more private, and closed nature of the learn/ALASKA audioconference network and the University Computer Network suggests an important spectrum of dynamics for research and consideration in utilizing the networks to the best effect for the range of information and learning services required by Alaskans for the distance delivery of education. As important as the distribution characteristics of each system are the dynamics of local access.

6.2 TELEVISION

Our television system is a public network received in virtually every home in the broadcast area of the local "mini" transmitter. To the extent that we are successful in securing VHF licenses, and prime cable channels at no user cost in cabled communities, the learn/ALASKA channel will provide maximum local in-home access. All television viewers will have access at the twist of a dial. This type of primary access suggests that viewers participating in a formal or informal learning project via television will be doing so independently, or within the informal context of familial companionship (rather than with classmates). The very open distribution and public nature of this system suggests that its strengths as an instructional/informational delivery system lie in the arena of broadly-based educational interests and needs. The more specialized and advanced levels of learning of interest and relevance to specialized learner groups appears problematic for our

setting at this point in the evolution of television in Alaska. As greater channel capacity becomes a reality a greater degree of instructional specialization will become feasible.

Alaska's four time zones pose unusual challenges in the statewide scheduling of one channel. As important as the time-zone considerations, are the distinct patterns of rural and urban lifestyles, and the way time is used. Live instructional programming may well give way to on-site automated recording of programming for delayed local broadcast or in-home/classroom use. The University Instructional Telecommunications Consortium has provided automated video tape recorders to many University sites to facilitate the latter type of use.

The video network is beginning service with the preponderance of programming coming from "lower 48" networks and distributors. The University and the Department are independently undertaking the production of instructional programming particularly relevant to the Alaskan setting. The Department's production is being contracted out, while the University is initiating in-house production through the Telecommunications Consoritum (UAITC), and local University units.

6.3 AUDIOCONFERENCING

The use of audioconferencing units (conveners) enables groups of participants at multiple sites to participate in group conferences with each other. Audioconferencing requires the timely attendance of all participants, as time on the network is allocated into a fully developed schedule. Local access to an audioconference is coordinated by the local Audio Site Coordinator. Effective use requires participants familiarity with the equipment (Push-to-talk microphones). The two wire system we currently use requires that only one participant talk at any one time; when two conversations are initiated simultaneously transmission is blocked. Thus, when the system is used informally (without a facilitator or chairperson directing participation), a good degree of participant familiarity with each other's speaking styles is required to avoid the "blockage" phenomenon. The more common, and more formal pattern of use is for the audioconference sponsor to serve as facilitator, or to request that another individual serve in this role to guide participation.

While it is technically feasible to use a hand phone set for participation in an audioconference, this type of use is discouraged for several reasons: costliness of individual lines being tied up (versus local users congregating at a designated site and using the convener); user discomfort which comes from extended discussion over a hand-held phone; and decreased sound quality. Thus, users must be able to conveniently access the local audioconferencing site.

6.4 COMPUTING

Use of the UACN requires user ability to gain access to a public or private terminal located at a University facility. Alternatively, access requires that the private micro-computer user have connect capability. In all instances, one must have a user identification name, assigned by the UACN to faculty, students, and staff so requesting. However, user file space, an important commodity for active users, is allocated differentially depending upon user status, and ability to state their case for file space. Access to campus-based terminals is problematic to most users at this time. University faculty and staff who are fortunate to have a terminal in their office enjoy better physical access than do most students currently. However, user demand has burgeoned in the last 12 months, so that physical access is just the first step to actually getting "on" the system. Saturation is most frequently occurring during office hours. The lack of time constraints involved with computer usage, one of the most potentially liberating dimensions of computer-based communication, is thus contradicted by the scarcity of network access.

7. THE EFFECTS OF PLANNING WHILE YOU "DO"

The rapid legislative response to the UA-DOE Feasibility Study which proposed comprehensive instructional telecommunications services for Alaska has required that we adopt a simultaneous planning and implementation strategy. The magnitude of system planning and implementation has been great, and the dynamics of University-State-School District relationships complex. We have moved a great distance very quickly; the next year promises additional rapid growth with the further extension of the television network to 120 new sites.

The focused attention which faculty/teachers, and students must receive in a manner which correlates with program production and adaptation has been underway since the inception of the networks. However, the consuming demands which network development has placed on us unquestionably diluted the magnitude of user support services which Alaskans, as learners, or providers of learning resources, require to harness the networks to their own ends.

Within the University and the Department of Education an increased emphasis on these two functions is now being addressed.

This past semester the UAITC and the University of Alaska-Fairbanks cosponsored a course on the social impact of instructional telecommunications in Alaska. The course was delivered via use of printed texts and readings, with student and faculty interaction occurring via the UACN electronic mail service and audioconferencing. Sixty students participated statewide. This course, offered by Ron Scollon and Suzanne B. Scollon, created important incentives for participants (many of whom are University faculty and staff) to gain proficiency in uses of the mail system and audioconference network. Audioconferencing among diverse sectors of the Alaskan educational community has become a relatively familiar and comfortable experience.

This next semester will see the first broad scale availability of the learn/ALASKA television service, and user orientation and experimentation in a stand-alone as well as complimentary capacity with audio and computer conferencing.

Basic research and exploration of the dynamics of inter-ethnic communication via telecommunications is in its infancy. Two productions which draw upon the British Broadcasting Corporation's productions on inter-ethnic communication in Great Britain, (the "Crosstalk" series), are now under development as pilot projects which explore communication in Alaskan cultural contexts.

Several Alaskan-based educational television series for children are in completion stages under contracts let by the Department of Education to Alaskan producers collaborating with local school districts.

Demand for user orientation, production services, and technical assistance exceeds our current capacity. We are moving to increase the depth of our services by integrating experience gained in other settings with our own experiential base.

In the next year we shall develop an instructional telecommunications plan in response to an executive order of the Governor which reorganized telecommunications services within Alaskan state government. This process, meshed with our respective internal planning sequences, is a significant "next step" in the further development of instructional telecommunications in Alaska.

FOOTNOTES

1. Alaska State Senate. "Senate Concurrent Resolution No. 35, Directing the Legislative Council to Conduct a Feasibility Study Relating to Educational Television." Juneau, Alaska. April 23, 1979.

2. Alaska Department of Education, University of Alaska, Alaska Public Broadcasting Commission. "A Report on the Feasibility of Telecommunications for Instruction in the State of Alaska." Juneau, Alaska. February 15, 1980.

3. Alaska State Legislature. "House Committee Substitute for Senate Bill 165 (Free Conference Committee). Making Appropriations for Operating and Capital Expenses Related to Telecommunications; And Providing for an Effective Date." July 2, 1980.

4. J. Barton and M. Lind. "Joint Memorandum to Mr. Robert Ward, Commissioner, Department of Transportation & Public Facilities." Fairbanks and Juneau. August 14, 1980 (date of transmission to Ward).

5. Alaska State Legislature. "Free Conference Committee Substitute for House Bill 50. Chapter 82. SLA 81." Juneau, Alaska. July 22, 1981, Effective Date July 23, 1981.

TELECOMMUNICATION SYSTEMS ENHANCE PARTICIPATORY GOVERNMENT

or

It Doesn't Have To End When You Leave the Voting Booth

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Abstract

The Alaska State Legislature has funded a network of information and communication facilities across the state. This paper is a discussion of these facilities and their use to inform the public of legislative activity and to facilitate involvement in the legislative process.

> To improve the means of communication ...is to extend to all the members of the human family the power of moving about and using the world which has been given to all as a common patrimony; it is to increase the rights and privileges of the greatest number as truly and as amply as could be done by electoral laws. I would go further--it is to establish democracy.
>
> Micel Chevalier
> 1806 - 1879
> French Ministry of Public Works

The Alaska State Legislature endorses public information services and has sought to involve the Alaskan citizenry in decisions made in their behalf. Years ago legislators realized that a wealth of technical knowledge, regional information, and constituent priorities existed in their home communities and they recognized that informed participation required apprising the citizens of legislative activity. The problem became finding the means to disseminate the information that was before the legislature while bringing the knowledge and the opinions from the home communities to the capitol, all the while avoiding the constraints imposed by travel. To meet that need, regional legislative information offices have been established throughout the state. Those offices are linked electronically with the capitol in Juneau by a data communication network and a voice communication network. How these networks are used is the subject of this paper.

A DIFFICULT ENVIRONMENT

Much has been said about the extremes of climate and geography that shape life in Alaska, yet it is necessary to understand the difficulty in communicating. Excluding the sixty percent of the population living in the three largest cities, Anchorage, Fairbanks, and Juneau, the residents are clustered throughout the state in small population centers. (See Figure 1.) These communities are connected by neither rail nor road. Air and water transport is often delayed for days because of fog, cold, or winds. Scheduled air service may be only twice weekly. Even when the weather is good, traveling from north to south in the state may take two days' air travel because of long waits between connecting flights. These hindrances affect passenger travel and freight, making transportation extemely costly and time consuming.

NETWORKS EVOLVE

The effort to reach out to the populace began in 1972 when the first regional information office was established in Anchorage. Fairbanks (1975), Ketchikan (1978), and Nome (1979) offices opened during ensuing years. Initially the offices were open only during the legislative session, and were limited primarily to the distribution of printed materials, though connected by teletype for inexpensive communication. These early offices were funded by the Legislative Council, on a site-by-site basis. The Legislative Council is the oversight committee of the Legislative Affairs Agency, a service agency of the legislature.

In 1977, Legislative Resolve 93 (see Appendix) called for the creation of the Legislative Teleconference Network to serve Anchorage, Bethel, Fairbanks, Ketchikan, Juneau, and Nome; the network began operations in February, 1978. Members of the Legislative Teleconference Network Task Force established general procedural guidelines to administer the new network and worked with the long lines carrier, RCA Alascom, to develop technical specifications for the network. (1) After the network had operated for one legislative session, staff produced a final report delineating the policies, procedures, and problems

encountered during that first session and recommending future direction. (2) Judged successful, the teleconference network was continued and expanded through funds included in a satellite services law enacted in 1978 (Chapter 161, Session Laws of Alaska 1978). (See Appendix.) Under the provisions of the law, the audio network was expanded from six to eleven sites, adding the communities of Barrow, Sitka, Soldotna, Kotzebue, and Kodiak in time for the next legislative session in January, 1979.

Demand for non-partisan information offices increased in those communities where the teleconference centers existed. In May, 1979, a Division of Public Services was established within the Legislative Affairs Agency to develop and administer a network of information offices and communication facilities. (See Figure 2.) The purpose of the Division of Public Services was to facilitate public participation in the legislative process and to provide the legislature with a method for direct communication with constituents. Regional information offices would provide information of record on legislative activity and would provide the means to communicate via a data communication network and via the audio teleconference network.

By the time the second session of the Eleventh Legislature convened in January, 1980, fully staffed and equipped information offices existed in the eleven communities previously linked by the audio conference network. Dillingham and Wasilla had also joined the legislative network with Valdez being included as a teleconference center only. By June, 1980, all of the legislative information offices had been funded for year-round operation, except for the Ketchikan office which was open only during the legislative session.

During the last six months of 1980, teleconference centers were authorized and established in Haines, Homer, Seward, and Sand Point. The newest regional information office, the Delta Junction office, was established in January, 1981.

The Alaska Information Office in Washington, D.C., opened in 1980. Although it is not administered by the Division of Public Services, the Alaska information office is connected to Alaska's legislative offices through data and voice circuits. The teleconference network has "drops" in several locations throughout the nation's capitol including the offices of Alaska's congressional delegation, in the office of the governor, and in the Alaska information office.

The Division of Public Services continues to receive requests for information to expand to new communities but as yet funding has not been approved. Currently, the teleconference network reaches seventy-five percent of the population in nineteen Alaskan communities. There are year-round information offices in thirteen Alaskan communities and teleconference centers in five; Ketchikan remains a session-only office.

FACILITIES

Two types of facilities have developed: the regional information office and the teleconference center. Legislative information offices are open year-round on a daily basis. They are stocked with printed reference materials. Connected by the data communication and the audio teleconference networks, the offices have terminal equipment associated with each which is described in greater detail below. The information offices have been established by the legislature both to inform the public and to facilitate communication between legislators and constituents.

Teleconference centers are staffed for scheduled teleconferences only and have only those reference materials which pertain to a particular teleconference. A teleconference center usually is located in borrowed space in a municipal building, library, or school. They have facsimile equipment, conference sets and microphones, but are not equipped with the data communication terminals described below. Thus, teleconference centers can facilitate communication but perform a limited public information role.

The regional information offices are linked by high quality data communication lines to the principal computer in Juneau. Each office is equipped with an IBM terminal comprising keyboard, CRT screen and printer. The Division of Administrative Services, Data Processing serves as both the control and program source for the Alaska Legislative Computer Systems (ALEXSYS). These terminals provide access to an electronic mail system and to several information retrieval programs which are briefly described below.

> STAIRS (Storage and Information Retrieval System), a document search program, allows an individual to search a variety of data bases. Currently "on-line" in all the legislative information offices are the entire body of the Alaska Statutes, all official versions of bills before the legislature, and the minutes of all finance committee meetings. A computer search capability enables the user to check references rapidly by subject.
>
> BASIS (Bill Action Status and Inquiry System) provides a variety of reports on the status of legislation. (See Figure 3.) Reports available include the history and action on a particular bill, bills currently before a committee, bills sponsored by a legislator, and a list of bills indexed by subject. The system is updated nightly from the journals with any action that has taken place during the floor session that day added to the base of information. Weekly reports are printed from this data

base and delivered to the information offices for wider distribution.

SIRS (Statute Inquiry Reference System) cross references the Alaska Statutes with pending legislation and creates a list showing measures affected by a statute or, conversely, statutes affected by a measure.

TELE (Teleconference Schedule) lists all future teleconferences that have been scheduled. Updated daily, it shows date, time, sponsor, subject, and sites included in each teleconference. A last minute addition or cancellation is immediately and simultaneously available at all legislative information offices throughout the state. Hard copies can be printed for wider distribution.

The previous systems described are for information retrieval only; the data flows one way, to the user, with the exception of the commands necessary to operate the system.

ATMS (Advanced Text Management System) is a system in which documents can be typed and stored to be revised or used in the future. The system can be connected to a high speed laser printer. ATMS is accessible at many terminals in Juneau, however, only a few of the remote sites can tap this program.

MSNG (Messenger) is a terminal-to-terminal electronic mail system which enables messages to be received or sent to one or many terminals and printers.

The above programs are available at numerous terminals throughout the capitol building and at the legislative information offices throughout the state.

The audio teleconference network provides another electronic link among the legislative information offices. It is a multi-point, four-wire dedicated circuit which allows interactive voice communication among nineteen Alaskan communities and Washington, D.C., twenty-four hours per day. Leased transmission facilities include a combination of satellite, microwave, and cable provided by Alascom, AT&T, and a number of local telephone companies.

Enhancing the voice plus data circuit is a selective signalling system which has several special features. This leased equipment is manufactured by Dantel. Normally, moderators have their conference telephones on at all times and are listening to activity on the circuit; they are signalled by a voice call. The Dantel equipment allows staff to ring moderators who have not turned on their sets. A privacy feature allows staff to exclude sites not scheduled to participate in a particular teleconference, thus avoiding inadvertent interruption or excessive line noise. The most frequently used feature of the Dantel equipment is the "offnet" capability which enables a call to be placed from the dedicated private line into the public telephone systems in Anchorage, Fairbanks, or Juneau. In effect, this feature expands the network to any location in the world which has telephone service. Eventually, the basic Dantel equipment could be modified to split the circuit into sections thereby providing the means to hold two or more meetings simultaneously on the one circuit.

The terminal equipment owned and maintained by the Division of Public Services includes a variety of loudspeakers and microphones which are operated by trained moderators and information officers. Western Electric 50A1 conference sets, Darome 624 Conveners and microphones, and Shure microphones and mixers are used in various combinations to meet the need of a given meeting. Operation is simple as the system is accessed merely by turning on a desk-top unit; consequently there is no need for highly trained technical personnel. The circuit terminates in several locations in each community thus allowing the local moderator to move the portable equipment to a meeting room suitable for the type of meeting and the size of the group.

Each regional information office and teleconference center has facsimile transmission capability. Larger offices are equipped with Xerox 200 Telecopiers for unattended transmission and reception via the regular telephone lines. All the offices and teleconference centers have Xerox 400 Telecopiers for use on either the telephone lines or the dedicated teleconference circuit. Facsimile transmission is especially valuable when, for example, a committee requests data from a citizen too late for it to be useful if sent by other means. Often facsimile is used to transmit copies of support documents, an agenda, a short bill, or a press release relating to a particular teleconference. This is an especially valuable tool for getting information to the teleconference centers because they have no other data communication equipment.

The regional information offices have many types of printed materials available for public use and distribution. These include, but are not limited to, copies of the Alaska Statutes, all versions of current bills, resolutions, and journals, and published reports to the legislature on a wide range of subjects. Commonly requested state and federal forms are available although requests other than those of a general nature must be referred to the appropriate agency. Air courier and express mail service are used to expedite delivery of printed materials to the remote sites within one or two days from being sent from Juneau.

OPERATIONS

The Juneau information office has a dual role in the system. Not only does it function as a regional facility while it serves the legislators and the citizens of Juneau, but it also functions as an information support facility to the regional offices. The Juneau office is also the administrative hub of the teleconference network, where all scheduling is done and support information for each teleconference originates. The office relies heavily on the data and audio network to accomplish this end.

Juneau personnel monitor and report on floor activity and committee hearings. The information is sent immediately via MESSENGER to the regional offices thus enabling the public to have timely and accurate information. Members of the division staff use electronic mail to share information regarding teleconference schedules, to arrange a meeting between a legislator and a constituent or to handle routine administrative matters. Toll calls are unnecessarily expensive and the postal service is too slow to effectively handle such communication.

Legislators and their staff use MESSENGER to have messages relating to legislative business sent to or from any of the regional offices for relay to third parties. Short public opinion messages from a constituent to his legislator or brief testimony from a citizen to a legislative committee may be sent instantaneously to the Juneau information office. The staff then delivers the message within the capitol building.

Members of the public are often interested in a specific subject rather than a particular bill. They may have heard that there is current legislation on a topic of interest to them but they have no further identifying details. In such cases computer programs that perform thorough and accurate searches by subject of the measures before the legislature are a valuable resource.

Three types of meetings are commonly held on the teleconference network and are open to the general public: the public hearing, the constituent meeting, and the work session. The public hearing is an extension of the legislative forum to communities other than Juneau. Hearing protocols are nearly the same as they would be with everyone gathered in a committee room of the capitol. Executive branch departments occasionally teleconference public hearings when receiving public comment on proposed regulation changes.

The constituent meeting is a meeting between a legislator or group of legislators in Juneau and the citizens of a particular voting district gathered at their local teleconference facility. These regularly scheduled meetings are often held in the evening, are not limited to a particular subject or bill, and are quite informal and relaxed. Often there is a wide representation of committee assignments among the legislators present who then can give a detailed analysis of the progress or implications of a wide variety of bills. Even if there are no formal public hearings scheduled on a given bill, it can be discussed at the constituent meeting. This forum allows legislators to respond immediately and directly to constituent concerns.

Work sessions, or business meetings, are scheduled more often when the legislature is not in session and represent the majority of non-legislative users. Because they are business meetings, specific individuals are invited to attend.

Because the teleconference network is located in public offices throughout the state and may be heard on conference sets whenever those offices are open, a person may listen to whatever is "on-line" at any given time. A citizen wishing to participate actively in a scheduled teleconference indicates his desire to the local information officer. Persons wishing to initiate a teleconference with a legislator or on a particular subject may request one by contacting his or her legislator or the appropriate committee chairman. This can be done using the public opinion message service offered at the information offices.

Teleconferences may be scheduled by the following groups, listed in order of their priority: the Alaska State Legislature, the executive and judicial branches, federal and local governments, and public nonprofit organizations.

Teleconferences are publicized in a variety of ways throughout the state. In some communities, the weekly schedule is announced on the local radio or TV station; other communities must rely on strategically located posters. Information officers can have immediate access to the constantly updated teleconference schedule by checking TELE on their terminals. Often they then alert citizens to hearings which may be of interest to them. Generally, any individual or interest group concerned with specific legislation or issues regularly contacts the local information office or teleconference center to obtain a schedule of future teleconferences.

DEMOCRACY IN ACTION

Other networks, both voice and data, are used as tools for government or business administration or for formal education; the Alaska network is unique in the nation in its legislative application. The entire network of information resources and communication opportunities is based on an elementary assumption about representative government that Alaska's legislature has made: when it is made easier for the public to increase its participation in the legislative process, it will do so. This has been the case in Alaska.

Citizens of Alaska have a basic opportunity to participate when electing their representatives to the House and the Senate, as well as the

governor, and the lieutenant governor. (See Figure 4.) These elected representatives of the people establish public policy and direction by enacting laws and appropriating monies. The bulk of the work of the legislature is accomplished within a number of committees which meet, hear witnesses, discuss the issues at hand, and develop the wording of proposed laws. It is during this committee process that the citizen has another chance to influence the legislative process directly by testifying at a legislative public hearing or indirectly by convincing a legislator of the validity of his position. Though this participation can take the form of written testimony, few want to relinquish the advantage of the power of the spoken word.

The information services provided by the regional offices allow the citizen to keep informed so that he is prepared when the opportunity arises to participate via the teleconference network or to go to Juneau and participate in person.

KOTZEBUE, FOR EXAMPLE

Kotzebue, a city of 2,054, is located on Alaska's northwest coast only 210 miles from Siberia and nearly 1,100 miles from Juneau. It serves as the regional center for the smaller villages surrounding it.

Mary, a nurse at the local health center, is interested in finding out if there is legislation pending on emergency health care and health care facilities. She stops by the Kotzebue Legislative Information Office so that she can check BASIS which reveals several bills pending. The printed form of the most current versions of the bills have not arrived in Kotzebue because the weather delayed air service. The text of the bills are called to the screen via STAIRS and then printed on the terminal printer.

Checking the current status of each bill, Mary finds that the Committee Substitute for House Bill 999 (HESS) is before the Judiciary Committee which will be hearing the bill the following Tuesday in Juneau and the following Thursday by teleconference. This is a funding bill necessary to ensure the continued operation of the health center, but it is worded in a manner that would exclude Kotzebue. Thus, a change in wording in a particular section is needed to keep the center open; Mary knows she must bring this to the committee's attention. Not only does the weather make travel to Juneau undesirable if not impossible, but the clinic has no budget for the $558 air fare and over $350 in living expenses, nor is there a suitable substitute during her five-day absence. A long distance telephone call, also expensive, lacks the impact of testimony at a public hearing. Since the committee will be holding the hearing by teleconference, she will be able to participate without incurring such a heavy cost.

On the day of the hearing, Mary goes to the information office in Kotzebue, registers, and waits to testify while listening to others speak from Barrow, Bethel, and Nome. Testifying before the Judiciary Committee, which is in Juneau, she provides them with facts and figures indicating the negative impact the legislation would have on Kotzebue and suggests a possible change in wording that would have a positive effect. As witnesses around the state listen, she concludes her testimony, having spent less than two hours as opposed to five days and nearly a thousand dollars.

As the weeks go by, Mary continues to track the progress of the bill through the House and the Senate. She attends her representative's monthly constituent teleconference, and enlists his support of the version of the bill with the revised wording. The bill finally passes both houses, is signed by the governor, and several days later is available in printed form at the Kotzebue information office.

DIFFICULTIES

Quite naturally, problems are bound to be encountered in the development of such widespread networks involving both people and technology. Many have been solved as the systems have evolved; others remain. They fall into two categories: human and technical.

Despite the realistic scenario above, one of the biggest problems still facing the Division of Public Services is informing the public of the existence of the information offices and teleconference centers and of the services available at them. While many of the smaller communities have achieved wide coverage, people in larger communities are continually discovering the presence of the teleconference facilities and of the resources at information offices which have existed for several years.

One drawback, rather than problem, of electronic communication is the potential for erroneous perceptions caused by lack of visual cues. The frenetic pace of the legislature during its short session is in no way apparent via the audio teleconference circuit. The legislators seem so close during a casual constituent meeting, yet the demands of their schedules may make it impossible to respond as they would like. News of intense activity on the floor which might postpone a teleconference spreads automatically through the capitol building but is not felt in the relaxed atmosphere of the teleconference site. While a participant may know there are a great many witnesses waiting throughout the state, it is difficult to feel their presence. The need to take measures to limit the length of testimony, for example, is more understandable when there are fifty witnesses gathered in a room than when there are only two or three people present at a teleconference site. Problems such as these can be ameliorated through better briefing or public education.

Finally, improving technical reliability of the electronic systems continues to be a primary goal. Within the last year, both the data and the teleconference systems have improved dramatically in accuracy and availability. Noise on the teleconference circuit was significantly reduced when new bridges were installed in Anchorage and Fairbanks. The selective signalling equipment allows some circuit tests to be done from a central location to help isolate the sources of problems.

Changes made by the Division of Administrative Services, Data Processing, are already correcting some problems. They recently converted the data system to a main computer dedicated solely to the legislature's uses. In the past, computer time was shared with the executive and judicial branches. As demands on the system will be fewer, response time should improve. A newly installed trouble-shooting system should allow for more rapid isolation of the source of the trouble and even permits remote reprogramming of the terminals. This will eliminate to some extent the need for a technician to make an hour-and-one-half flight to Barrow, for example, to bring a terminal back into service. Already improvements are apparent.

SPECIAL SUCCESSES

Much has been said implicitly of the overall success of the legislative information offices and the teleconference network. Little credit has been given so far to the enthusiastic, competent employees who make the systems run. The regional offices often have only one or two personnel who must assimilate and share a wealth of information, moderate teleconferences, manage public relations, and upon occasion, repair equipment. Information officers are hired from the community they serve. A particular strong point is that many of the staff in the rural communities are bilingual in English and either Yupik or Inupiak Eskimo. Testimony in the Eskimo tongue has been given by witnesses via teleconference and translated for the record. An example of a successful effort to bridge the cultural gap between persons accustomed to a traditional subsistence way of life and those dependent upon modern technology.

The teleconference circuit has been greatly enhanced by the "offnet" feature. No longer limited by the twenty permanent locations, committees can now receive testimony from an expert witness in Atlanta, Georgia or a snowbound citizen in Allakaket. Although arrangements must be made in advance, the ability to go "offnet" truly extends the legislative forum to the entire state.

A WORD ABOUT VIDEO TELECONFERENCES

Video teleconferencing has been one of the services offered since the inception of the audio network in 1978. Full-motion, two-way video conferencing is available in seven communities in the state, requiring the cooperation of several television studios and the state agency which schedules use of a state-leased satellite transponder. Video teleconferences do not use a system that is in place at all times as is the audio network, and therefore take much more time to coordinate, are more expensive, and are not used daily as are the other systems. Earlier assessments of video teleconferencing hesitate to make a judgement of its value over audio conferencing. (3) Video conferencing will likely continue as the legislature demonstrates new applications to the legislative process.

FUTURE DIRECTIONS

An issue previously before the legislature and likely to reappear in the near future is the legality of meetings held and testimony taken by electronic means. Needed is clear language delineating acceptable and unacceptable criteria for verifying identity, defining a public hearing, and related matters. To this point, these have been assumed.

The horizon holds visions of readier access to all the information resources mentioned in this paper. Home and office computer systems are already widely available; dial access is nearly so. Cable TV networks have public access channels whose programming could be day-long legislative activity. Interactive cable systems exist although they are not operational in Alaska yet. How long before we need to take only five steps to reach our television set to testify before the legislature?

REFERENCES

(1) Goldin, Lawrence. Legislative Teleconference Task Force Report, December 1977.

(2) Fromuth, Peter. Final Report on Teleconferencing, July 1978.

(3) Plummer, Sioux. Public Involvement in the Legislative Process Through Teleconferencing, May 1980.

Anchorage	173,017	Ketchikan	7,198
Barrow	2,207	Kodiak	4,756
Bethel	3,576	Kotzebue	2,054
Delta Junction	945	Nome	2,301
Dillingham	1,563	Sand Point	625
Fairbanks	22,645	Seward	1,843
Haines	993	Sitka	7,803
Homer	2,209	Soldotna	2,320
Juneau	19,528	Valdez	3,079
		Wasilla	1,559

LEGEND

X Teleconference Site

● Information Office

● State Capital

FIGURE 1. PUBLIC SERVICES FACILITY LOCATIONS

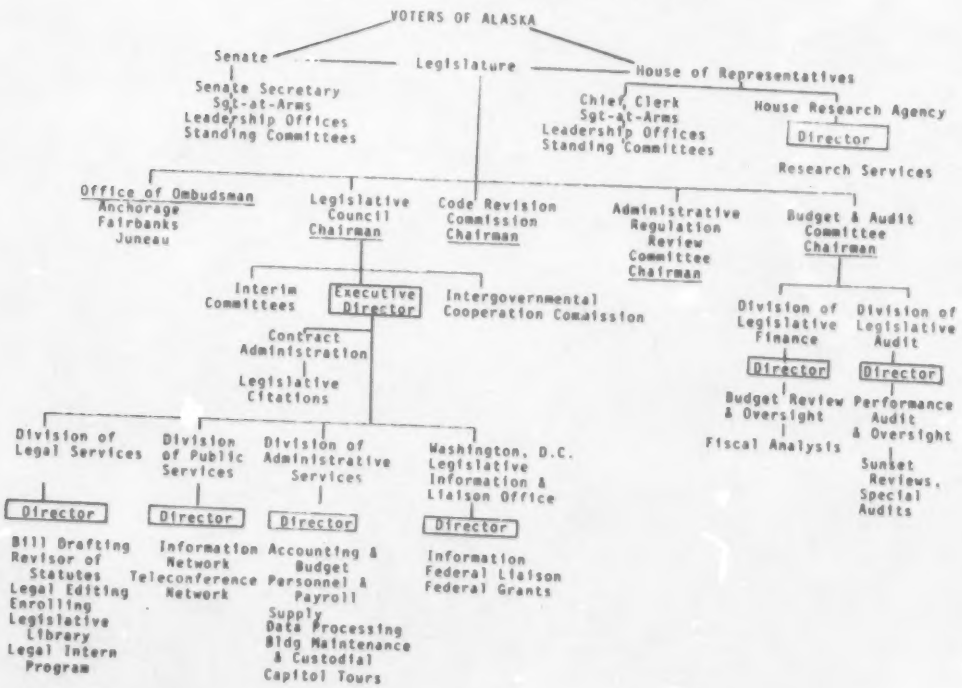

FIGURE 2. ORGANIZATION OF THE LEGISLATURE

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                                                                    * * * * * *
                                                                      * * * * *
                                                                        * * * *
        AA      LL              AA       SS S SS   KK   KK        AA
       AAAA     LL             AAAA     SS     SS  KK  KK        AAAA
      AA  AA    LL            AA  AA      SS       KK KK        AA  AA
     AA AA AA   LL           AA AA AA        SS    KKK KK      AA AA AA
    AA      AA  LL          AA      AA  SS     SS  KK   KK    AA     AA
   AA        AA LL LL LL LL AA        AA  SS S SS  KK    KK AA       AA
* * * *                                                          * * * *
* * * * *                                                        * * * * *
* * * * * *                                                      * * * * * *

                BILL ACTION & STATUS INQUIRY SYSTEM (BASIS)
ENTER:
      BILL IDENTIFICATION...
      SPONSOR NAME.........                          HOUSE ?   SENATE ?
      COMMITTEE NAME.......                          HOUSE ?   SENATE ?
      SUBJECT SUMMARY......
      AWAITING ACTION..... ?
          USE ARROW KEY (ADJACENT TO '0') TO POSITION CURSOR...
          *FOR HELP PF1 OR PF13 : *FOR A VALID SPONSOR LIST PF2 OR PF14
```

FIGURE 3. BASIS MENU SCREEN

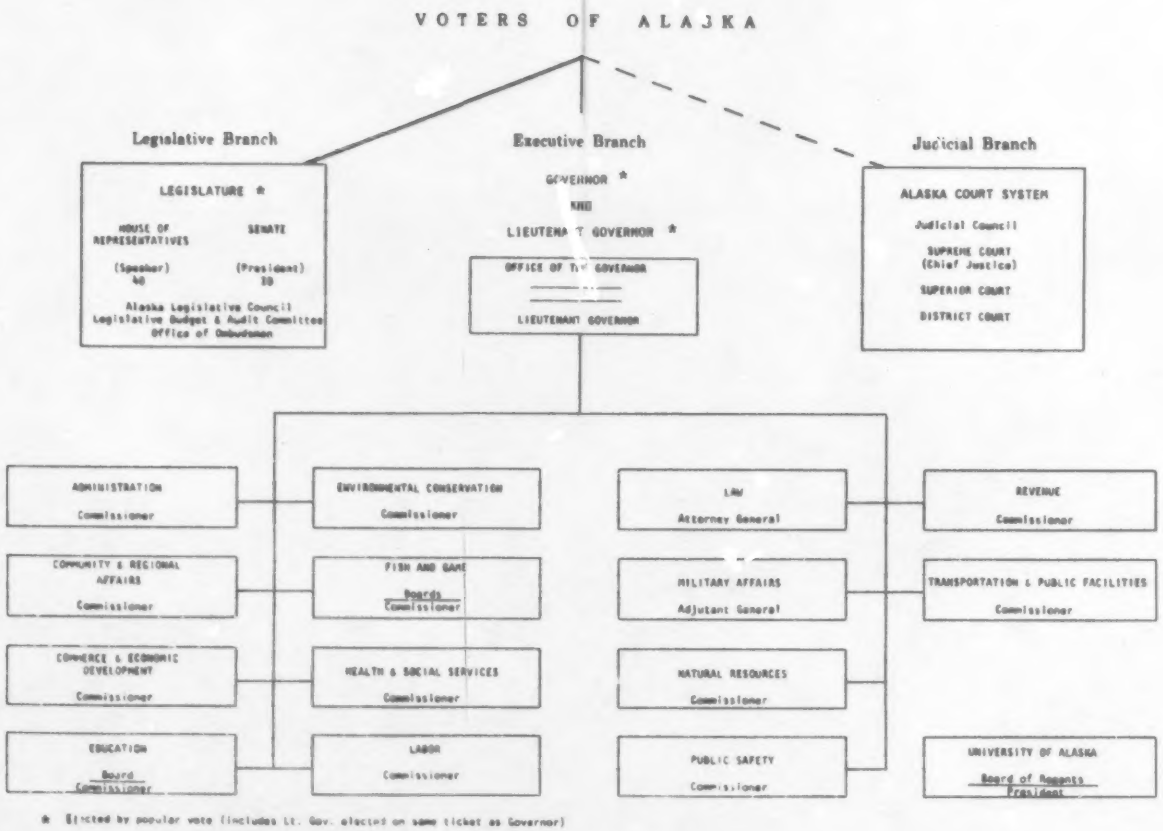

FIGURE 4. ORGANIZATION OF STATE GOVERNMENT

APPENDIX

I. Legislative Resolve 93, 1977

Source: House CS for Senate Concurrent Resolution 57 am H

II. Chapter 161, SLA 78

Source: Senate CS for CS for House Bill No. 908 (Rules) am S

Introduced: 4/30/77
Referred: Rules

IN THE SENATE BY SACKETT

SENATE CONCURRENT RESOLUTION NO. 57 am H

IN THE LEGISLATURE OF THE STATE OF ALASKA

TENTH LEGISLATURE - FIRST SESSION

Relating to a legislative teleconferencing network.

BE IT RESOLVED BY THE LEGISLATURE OF THE STATE OF ALASKA:

WHEREAS the use of teleconferencing has been demonstrated to be useful and desirable in broadening the two-way contact between constituents and legislators; and

WHEREAS increased use of teleconferencing can extend legislative responsiveness to the public and can increase public confidence in the legislature;

BE IT RESOLVED by the Alaska State Legislature that the Legislative Council is directed to form a Legislative Teleconferencing Network Task Force based upon the following criteria:

(1) The chairman of the Legislative Council shall be the chairman of the task force.

(2) The chairman of the Legislative Council shall appoint five members to the task force from the legislature to represent the reasonable needs of the legislature which a teleconferencing network must recognize in order to be successful. Preference shall be given to those legislators who represent communities receiving the first teleconferencing stations; however, no more than one legislator from each community may be appointed to the task force.

(3) The Legislative Council shall request the Alaska Public Broadcasting Commission to appoint 10 members to the task force to represent the reasonable needs of communities which a teleconferencing network must recognize in order to be successful. These members shall be appointed in accordance with the following guidelines:

(A) an equal number of members, representing the communities from which they are chosen, shall be chosen from each of the communities receiving the first teleconferencing centers;

(B) each member shall have demonstrated an involvement in community affairs and a commitment to increasing citizen participation in policy making;

(C) no member may have a financial interest in the telecommunications industry;

(4) The task force shall have no more than 20 members; and be it

FURTHER RESOLVED that the purpose of the task force is to make recommendations to the Legislative Council concerning a system design for a teleconferencing network based on the following guidelines:

(1) The system shall operate in Anchorage, Bethel, Fairbanks, Juneau, and Nome with allowance for expansion into other communities in the future as those other communities develop the necessary technical capabilities

(2) The system shall provide residents of the communities affected with an easy-to-use means of participating in legislative committee hearings and obtaining information about legislation.

(3) The system shall be a closed circuit system with transmission between the capital and centrally located community teleconferencing centers in the communities affected. Constituents wishing to testify shall report to these community teleconferencing centers in accordance with recommendations made by the task force.

(4) The system shall be operational by January 15, 1978.

(5) The task force shall consider both technical and managerial components of the system drawing upon the expertise of the state office of telecommunications and any legislative committee on telecommunications and make reasonable compromises in the event of conflicting needs of user groups; and be it

FURTHER RESOLVED that nothing in this resolution shall be interpreted or construed as regulating any broadcasting entity, public or private, or in any manner interfering with efforts of the Alaska Public Broadcasting Commission to provide timely legislative news coverage; and be it

FURTHER RESOLVED that it is not the purpose of this resolution to provide a system for broadcasting committee hearings directly into people's homes, although that option may be made available to local broadcasters if they determine that local interest warrants it; and be it

FURTHER RESOLVED that the Legislative Council shall receive the recommendations of the task force and, subject to the Council's approval, transmit them to the Legislative Affairs Agency for implementation and administration; and be it

FURTHER RESOLVED that the Legislative Affairs Agency may contract with the state office of telecommunications or other source of technical expertise for the implementation of the recommended program; and be it

FURTHER RESOLVED that once operational the system shall be administered by the Legislative Affairs Agency and when feasible the Legislative Affairs Agency may make the system available to other governmental agencies on a reimbursable costs basis; and be it

FURTHER RESOLVED that the Legislative Affairs Agency shall carry out a program of public education and encouragement relating to the use of the legislative teleconferencing network system.

Original sponsor: State Affairs Committee Offered: 6/16/78

IN THE HOUSE BY THE RULES COMMITTEE

SENATE CS FOR CS FOR HOUSE BILL NO. 908 (Rules) am S

IN THE LEGISLATURE OF THE STATE OF ALASKA

TENTH LEGISLATURE - [illegible] SESSION

A BILL

For an Act entitled: "An Act making miscellaneous appropriations for television and telecommunication services; and providing for an effective date."

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

* Section 1. The sum of $10,948,000 is appropriated to the Department of Administration to provide interstate and intrastate satellite television service to 176 Alaska communities through contract with a properly licensed private business enterprise and to contract with any private business enterprise for the construction of earth stations to be owned by entities other than the state. This appropriation is funded from the following sources:

General Funds	$ 6,148,000
Program Receipts	4,800,000

* Sec. 2. The sum of $1,587,000 is appropriated from the general fund to the Department of Administration for the purchase and installation of mini-TV transmitters for 127 communities.

* Sec. 3. The sum of $80,000 is appropriated from the general fund to the Department of Education to continue and expand the present public and educational television services to Alaskan rural communities through fiscal year 1979.

* Sec. 4. The sum of $400,000 is appropriated from the general fund to the Alaska Public Broadcasting Commission to fund grants for the production of television and radio programs for educational and public purposes.

* Sec. 5. The sum of $125,000 is appropriated from the general fund to the Alaska Public Broadcasting Commission for operation of the tape delay

center in Anchorage.

* Sec. 6. The sum of $25,000 is appropriated from the general fund to the Alaska Public Broadcasting Commission for the purchase of electronic equipment to distribute television services within the KYUK network.

* Sec. 7. The sum of $232,972 is appropriated from the general fund to the Legislative Affairs Agency for legislative teleconferencing for fiscal year 1979.

* Sec. 8. The sum of $50,000 is appropriated from the general fund to the Department of Administration for purchasing time and providing services for teleconferencing meetings of state agencies and executive boards and commissions.

* Sec. 9. The unexpended and unobligated portions of the appropriations made in secs. 2 - 8 of this Act lapse into the general fund June 30, 1979. The unexpended and unobligated portion of the appropriation made in sec. 1 of this Act lapses into the general fund June 30, 1981.

COMMUNITY INFORMATION CENTERS: ACCESS TO A TOTAL COMMUNICATION SYSTEM (1)

C. R. Taylor
Juneau, Alaska

Abstract

Access to electronically-stored data and communication with others are essential to growth in Alaska and other less developed areas. Expensive terminal equipment can be shared by many users in a library-type enviornment to keep unit costs affordable. Implementation of Community Information Centers (CIC) where teleconferencing facilities, computer terminals and facsimile equipment are available will provide needed services. CIC's are applicable to any community, whether rural or urban, and should be accessible to all responsible individuals.

INTRODUCTION

Because of its size, low population, rugged terrain and harsh climate, the Alaskan enviornment imposes immense burdens on agencies responsible for delivery of health, education and social services. Lack of convenient transportation, coupled with the high cost of the available services, further aggravates the situation, emphasizing the need for telecommunications as an alternative.

As with any developing region, an extraordinary amount of support activity is required in the rural areas. Most Alaska communities are too small to warrant the full complex of facilities for education, health, other social services and general access to information that is available in urban centers. Without such resources, development is slowed and made more costly. The customary approach (definitely not the solution) in Alaska has been to transport personnel and information to the bush in an effort to transfer information from where it resides to where it is needed. This is not inexpensive. Although the average trip costs between $300 and $400, it can cost as much as $2500 for someone to travel from an Aleutian community to Anchorage and back. Not infrequently, due to the incredibly bad weather, the $2500 is spent to get someone to a conference just as it is ending. The University of Alaska employs circuit professors who may be based in Fairbanks and teach one class per week in Juneau, Sitka and Ketchikan, accumulating over 80,000 miles in an academic year - for 50 students or less.

The preceding examples are extreme, of course; but they serve to highlight a principle and a problem we feel acutely: that, within reason, every citizen of our nation is entitled to an adequate degree of information access and communication capability, regardless of his location. Yet it is not feasible for instructors to remain in the small communities for extended periods of time, nor can village residents ignore their jobs and their domestic obligations long enough to obtain adequate education at urban centers. As an example which came to light recently, the Bureau of Land Management is developing regulations related to land disposal requirements derived from the Native Claims Act. Nearly 20 new regulations were scheduled to be "promulgated," i.e., described to pertinent personnel in most of the state's regional centers during 1978. Typically, promulgation requires meetings in which experts describe the new laws to the citizens and answer the resulting questions. In this specific case, BLM had no money budgeted for travel to the eighty-plus meetings that were required. Although this example involves expenses of $50,000 or so, it is only one of many of a similar nature.

AGGREGATING USERS

Obviously we are setting the stage for introducing the concept of "telecommunications as a subsitutue for transportation," a concept which, under the impetus of high energy costs, is reaching fad-like proportions these days. The other theme we would like to explore is also popular; that of aggregating users in order to lower unit service costs. The unique aspect is that we are seeking to aggregate users for terminal equipment as well as the communications circuits themselves.

Alaska has been promoting activities directed toward development of cost-effective telecommunication systems by making common facilities available to many users. We have shown the advantages of sharing a communication satellite transponder by several users: (1) television broadcasters bring programming to the state on the day of broadcast instead of several weeks later by videotape mailed from the contiguous states; (2) rural communities receive more than six hours of prime-time news, sports and entertainment each day; and (3) educational institutions distribute several hours per day of instructional television to classrooms and to homes. Approximately 5000 hours of programming per year are distributed via this system at an average hourly cost of $100. The per capita cost is nearly negligible.

Video programming can greatly enhance the instructional process, but alternative services which are far less expensive may also be employed very effectively. Narrow-band communication services can usually deliver far more usable information per dollar than can television. Because the amount of data that the standard television signal can deliver is thousands of times greater than the human can absorb, the cost of information actually obtained is relatively high when contrasted with sources based upon narrow-band techniques such as teletype, computer communications or facsimile. One of the problems associated with narrow-band techniques is the relatively high cost of terminal equipment: the CRT terminals, keyboard-printout machines, facsimile equipment, etc. It is generally difficult to justify purchase of services requiring such equipment if it is utilized only infrequently. Yet the penalty for not having access to the services can be immense. Obviously, the lowest possible costs can be achieved by making the same facilities available to as many users as possible. This requires a means which makes it easy for any person, within reasonable limitations, to utilize the facilities. And that brings us to the Community Information Center concept.

BASIC CONCEPT

A Community Information Center is simply a location where the public and state agencies can utilize terminal equipment to access information and to communicate with others. Most communities are small enough that a single location will adequately serve all potential users. We envision a facility much like a small branch library that might contain the essential references and other publications in text and microfiche. It would be equipped with one or more data terminals with video display and hard-copy capability. A standard facsimile machine would be available. A small conference room would be equipped with at least one video monitor and videotape recorder, and be instrumented for quality audio teleconferencing. And, still a novelty in some Alaska communities, there would be a telephone.

The foregoing list of equipment represents a minimum core facility which might be augmented with additional equipment or other types of devices as appropriate. Two-way video capability appears warranted for many purposes, but adds a cost increment that may be excessive. All of our planning is based upon the assumption that the centers are economically feasible, that the increase in efficiency and savings in travel will offset their cost. We believe that the users should be charged directly on the basis of cost; whether the CIC's should be fully supported by users' fees or partially funded via the taxation process is a policy question to be resolved later.

As in a conventional library, universal access is essential. The center must be available to all citizens regardless of their status. It should be no more difficult to obtain a user account number than a library card or, at worst, since charges would be levied, a credit card. Any responsible member of a community should have the right to utilize the facilities which may eventually be treated as casually as the use of a library, the postal system or the telephone.

Again, as in libraries, an attendant would be present at each CIC to serve as custodian and to assist those using the center. This person would schedule use of the facilities where necessary, coordinating the users and observing priorities which may be required to guarantee equitable access. In Alaska, our plans are for these personnel to be drawn from local citizens wherever possible, given a short course in basics and then, through the system itself, given advanced training while on the job. We are confident it will be possible for paraprofessionals to adequately manage the centers, for they can rely upon the communication system to consult with resource personnel located in other places. In fact, the existence of CIC's should help stimulate development of consulting and information services intended for general public access.

Teleconferencing, among the many services a CIC could provide, has the potential for increasing organizational effectiveness and/or reducing travel expenditures. In Alaska we are entering into our second year of an operational teleconferencing system intended primarily for legislative users. It is very difficult for the Legislature to be responsive to the state's citizens in an equitable manner, for some have no means of getting to the Capitol while others have no trouble doing so. Recognizing this, the state Legislature established a teleconferencing network reaching six communities during the 1978 session. It has now been expanded to cover eleven places for the session beginning in January 1979. Further the offices or our two senators and one representative, plus the Governor's Office in Washington, D.C., are also connected. Two-way video capability is available at eight locations within Alaska; all have full audio conferencing equipment.

We find that legislative committe hearings are made to order for videoconferencing. These hearings are relatively formal and well disciplined; the citizen testifying sits at one end of a table with the committee members clustered around the other end. This arrangement can be split, with the citizen sitting before a television camera and video monitor at a distant location, viewing and being viewed by the committee through similar equipment in the hearing room. The person testifying is, in nearly all respects, "in" the room with the committee; he

can see the members watching (or ignoring) him and observe their reactions. They, of course, can also observe him.

Videoconferencing can, for many applications, be very effective; but it is costly in terms of equipment and in telecommunication services. Audio conferencing can be employed in a high percentage of cases, especially where the participants are known to each other. Teleconferencing can eliminate the need for a significant percentage of trips made for routine administrative purposes. The cost of audio conferencing is almost negligible compared to travelexpenses. Videoconferencing expenses are still low in contrast to travel.

One-way video, the capability to receive television programming, offers many services with which we are all familiar. In-service training for teachers and health support personnel can be given very effectively, especially if audio conferencing circuits are present to allow student-teacher interaction. Because otherwise heavily used video circuits are generally not in use from midnight until dawn, the incremental cost of transmitting television during these hours should be low. Teachers and others who want specific segments of instructional programming should be able to make requests in advance and have their material transmitted to their unattended recorders during the early morning hours, to be retrieved and viewed whenever wanted.

The CIC doesn't have to be a drab, foreboding place. There should be no reason why entertainment programming could not be shown, if there were no demand for more serious uses at a particular time.

In Alaska, where it sometimes takes weeks for a letter to reach its destination, facsimile transmission of written documents has the potential for speeding up administrative processes by an order or magnitude. Many transactions in government and business require several cycles of correspondence. Months of delay can be reduced to days with electronic document transmission.

Computer terminals will offer nearly unlimited opportunities to obtain data and services, as the information utility concept grows over the ensuing years. Individuals can utilize computer facilities for computational purposes, for preparing income tax or even game playing. As long as they pay for the services used, the use should be left to the discretion of the users. As with television, computer-based instruction offers a wide spectrum of courses available to individual students. Small businesses and village corporations can use these common facilities for management purposes.

Computer-based mail systems have a very high potential value in Alaska where conventional mail service is so slow and where many people are constantly on the move. The University of Alaska has had a mailbox system in use for several years. Several thousand people in the state are using it to leave messages for other members of the system. By going to any data terminal capable of accessing the system, one can type in a message for others. The recipient must check his terminal occasionally to see if there is any mail. One of the advantages of the mailbox concept is that the message does not have to be sent to any particular location; it is sent to the "mailbox" where it is stored until requested. This enables correspondence to be maintained with persons who are traveling about the state or elsewhere. Personnel in our office have used the system while in Washington, D.C., by locating a compatible terminal and dialing up the computer in Alaska. This has proven invaluable, for it is very difficult to find a time for a telephone call when confronted with a busy schedule of meetings and burdened by a five-hour time zone difference.

CONCLUSION

The Community Information Center has been described as we now conceive it. Rather than a specific configuration of equipment, it is the function and the manner of use that we think is important. It is also important that it be economically feasible and that its users be willing to cover its cost of operation, in one way or another. It won't be possible to produce a standard model and drop it down in each community, nor is it necessary, for the concept is a flexible one, adaptable to specific requirements.

We feel that each facility should be as small as is economically feasible, yet large enough to attract the number of users needed to support the full range of equipment. It seems better to emphasize ease of access within a community than to go to extreems in reducing costs by placing all resources in one large central location. We have some well-developed ideas for CIC's, but feel that further commitment requires data based on demonstrated use. We need to learn more about user preferences, not just from questionnaires but from hands-on experience. Then this information can be used to plan for further development.

In order to obtain the needed data, we are currently working to establish a demonstration project based upon the existing Legislative Teleconference system. We hope to obtain funding to allow construction of CIC's in seventeen regional and urban centers in the state. The total cost of operating these centers is less than ten percent of the state government's travel expenditures. It would seem that, with state, federal, business and individual personnel utilizing the facilities, they would be cost effective. We need further information that is based upon demonstrated evidence, however, to be sure.

We have placed the CIC in a rural context, but that does not necessarily rule out its value in urban enviornments, for the same types of facilities will be needed everywhere. Until we reach the stage where such capabilities will be in every home, it seems that some form of readily accessible center for obtaining information of all types is needed. We hope that this concept can be tested, explored

and developed, in order to facilitate communication and access to data which are becoming necessities to everyone in our information society, whether in the bush, the suburbs or the inner city. We believe the time to pursue this concept has come and that the situation we have in Alaska will make it possible for us to contribute to its development.

(1) Editor's note

This paper was prepared in late 1978 for PTC '79 and has not been updated. Mr. Taylor was a staff member of the Office of Telecommunications at that time. The Office was disbanded in mid-1979 and the project mentioned never materialized.

Television

The Alaska Television Demonstration Project
Past, Present and ... Future?

Theodore W. McIntire
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Division of Telecommunications Services
Alaska State Department of Administration

Abstract

In 1976 the State of Alaska instituted a project to demonstrate the possibility of providing television to remote areas of the state by satellite. That the demonstration was successful is attested to by the fact that the original demonstration system has grown to the point that over 200 communities are now slated for service. However, when the costs of the state-funded system are compared with alternative sources of television programming and delivery now available, there may be good reason to consider whether the state should continue the present system.

BACKGROUND

The Alaska Satellite Television Demonstration project (TVDP) was instituted to demonstrate the feasibility of delivering television programs to small communities and to provide "real-time" network programs to urban areas via communications satellite.

The opportunity to conduct such a demonstration came with the construction of satellite earth stations to provide telephone service throughout the state. Up to this time no television delivery systems employing commercial satellites and receiving stations as small as those being installed in rural Alaska had been constructed. Investigations indicated that it would be possible to design a system that would allow quality television to be received through these stations.

In 1976 the Alaska State Legislature passed a bill appropriating $1,500,000 to the Office of the Governor, Office of Telecommunications, for a project to demonstrate the distribution of television programming in Alaska via satellite.

A considerable amount of work on the technical parameters of the system, including development of a method for delivering two television channels simultaneously through a single transponder, was accomplished before the funding legislation was passed.

Once funding was assured, the state was faced with the problems of selecting equipment vendors, negotiating service agreements with RCA Alascom, selection of sites, and setting up management systems and policies that would be responsive to the viewing public, broadcasters, and public service agencies, all of whom would have a participatory interest in the system. Most of these problems were resolved through meetings and negotiations with representatives of the involved groups. The first satellite-fed mini-TV station went on the air at Tenakee Springs (population 100) in January of 1977.

SYSTEM CONFIGURATION AND OPERATION

The system employed for the Television Demonstration Project provides two general types of service: interstate and intrastate. The interstate services are utilized primarily for the delivery of the network programs to Alaska television broadcasters. The intrastate part of the system is utilized to deliver entertainment and public service programming between points within the state. Different modes (or formats) of transmission are employed to obtain maximum use of the system which is characterized by earth stations of different sizes.

The basic system includes RCA Americom's F2 satellite (transponder 23), up/downlink facilities at Alascom's major earth stations at Talkeetna and Juneau, downlink facilities at Alascom's small (4.5-meter) and mid-route (10-meter) earth stations throughout the state, and several state-owned receive-only earth stations located in communities that have terrestrial telephone long-line service and therefore no need for a telephone earth station. In addition, earth stations in the continental United States are employed, as scheduling requires, to transmit network programming to commercial broadcasters in Alaska.

Programming is distributed locally in small communities by means of a low power (10-watt) television transmitter that is fed directly with the video and audio signals received at the local earth station.

Interstate Service

Programming for interstate service originates with network broadcast stations on the east and west coasts of the United States. The principal users of this service are Alaska television broadcasters for whom it provides time-value programs. Secondary users are cable systems that have rights to particular programs. Depending on the transmission format used, certain programs (news, sports, special events, etc.)

carried in interstate service are received by the small earth stations. The two channel per transponder method of transmission, which was developed for the TVP, allows simultaneous delivery of two separate video programs through one satellite transponder. This mode is used only to deliver network programs to broadcasters in Alaska when program schedules require it. Programs transmitted in this mode can be received only at communities that are served by Alascom earth stations with 10-meter or larger antennas. These are generally found only in the state's larger cities (over 2,000 population). As a result, during dual channel transmission periods the rural system is, in effect, blacked out. This transmission mode is used less frequently now, for reasons explained later.

Intrastate Service

Most intrastate traffic in the demonstration project consists of programming for reception in rural communities. This consists of educational and public service programs interspersed throughout the morning and afternoon hours. Occasional use of the intrastate capability is made to distribute Alaska-originated programs, such as legislative news, to broadcast stations within the state and to provide a closed-circuit type of service to one point, or a limited number of points, for specialized programs such as video conferencing. The video conferencing capability is occasionally used by legislative committees for public hearings.

Entertainment programs are obtained from the three major network broadcast stations in Anchorage. These programs are recorded at the time of broadcast in Anchorage and the tapes delivered to the state-operated tape center where they are played back at the appropriate time for the rural network.

System Management

Responsibility for management of various facets of the TVP has been transferred from one state agency to another since the project's inception in 1976. Early in 1981 Governor Hammond issued an executive order (E.O. #50, 1981) establishing a telecommunications section within the Department of Administration. This order became law on July 1, 1981, and all responsibilities for operation and management of the TVP were transferred to the Department of Administration. Under Executive Order #50 two new divisions were established: Telecommunications Services and Telecommunications Systems. The services division is responsible for planning and for assistance to state agencies on telecommunications matters, while the systems division is responsible for design, installation, maintenance, and operation of state-owned telecommunications facilities, including the TVP.

The day-to-day operation of the system involves such activities as making up program schedules, placing program orders with television carriers and broadcasters, and operating the tape delay center from which the programs for statewide viewer consumption originate.

Installation and maintenance activities include the installation of mini transmitters, and receive-only earth stations where appropriate commercial earth stations do not exist, and maintenance of all state-owned equipment involved in the system. The systems division is also responsible for placing orders for equipment and services that are provided by Alascom. Installation and maintenance work is performed either by division personnel or by private contracts as dictated by the exigencies of the local situation.

Policy

Programming and programming policies were established through agreement of the users early in the project. The essence of this agreement is that certain time blocks are assigned to commercial broadcasters for delivery of real-time network programs from the lower 48, the evening hours are reserved solely for the transmission of general programming to rural areas, and the remaining time is available for educational and other public service programming. It is occasionally necessary to make short-term changes in these time allocations due to special television events. However, when changes or compromises are required, they are generally worked out with the agreement of affected users. If there is one overriding program management policy, it is that the state avoid any direct involvement in the selection of programs to be carried.

WHERE IT IS TODAY

While the first year of the demonstration project showed the system to be neither technically nor operationally flawless, it worked far better than many had thought possible. One of the more frequently heard observations from residents of urban communities was: "Those people in the bush get better television than we do." While, in some cases, this may have been an exaggeration, it was not surprising that under pressure from their constituents legislators continued to vote for appropriations that would expand the project to more communities. Each year since 1976 funds for continuation and expansion have been appropriated. When installation of facilities funded to date have been completed, 203 communities will be receiving the state-funded service. This number does not include major cities and their suburbs which are served by commercial broadcast stations.

In addition to funds for continuation and expansion of the original television project, the

legislature in 1980 provided funding for an instructional television (ITV) project. This project established a system that provides a full-time satellite-based instructional television channel. This system is technically similar, and generally parallel, to the original project, but is operationally separate. The ITV project is discussed in other papers.

Not surprisingly, the expansion of the TVP has created pressures for increased service. As the satellite scheduling was originally set up, day-time periods on weekends were generally reserved for delivery of live sports programs to commercial network broadcast stations. Often two or more events carried by separate networks were going on simultaneously, and, in order to accommodate the requests of broadcasters, it was necessary to employ the two-channel format, which cannot be received at the small earth stations. This did not cause a great deal of consternation when service was being provided only to small and remote communities. In fact, early program preference polls indicated that sports programs were among those "least liked" by rural audiences. However, as the system expanded to include the more urbanized communities and as rural viewers began to develop an interest in and liking for sports events, grumblings were heard in the capital. This led the legislature to appropriate funds for the purchase of additional transponder time to accommodate the demands of both rural viewers and broadcasters. When additional transponder time is needed, it is purchased at the carrier's tariffed occasional-use rate. Depending on scheduling requirements, this will result in additional expenditures of $250,000 to $500,000 per year.

When the expansions that have been funded to date are completed, approximately 90 percent of the population of the state will have access to at least one channel of television. The annual operating cost of the completed system is expected to be approximately $4.5 million or $10 per year per capita.

The cost-per-capita figure taken alone does not appear inordinately high; however, when it is noted that approximately half of the state's population resides in or near Anchorage where three commercial TV broadcast stations are located, and that three other urban centers, Fairbanks, Juneau, and Sitka, have commercial broadcast stations, we see that 70 percent of the population does not depend on the state system for broadcast television. Commercial broadcast audiences do, however, receive some real-time programming that local stations might not have been able to provide without state support. In essence, the state will be spending over $4 million per year to provide "free" television service to slightly over 80,000 people who would not otherwise have it ($50 per year per capita).

WHERE DO WE GO FROM HERE?

Since television has become an accepted and somewhat important part of modern American life, it is not unreasonable to take the stand that public money may properly be used to provide television service to citizens living in areas that do not have a sufficient economic base to attract commercial broadcast stations. The next question should be: How can this money best be spent?

If we assume four persons per family, the cost of providing state-funded service to those who have no other source of broadcast television is $21 per month per family. This cost is in the range of what many Alaskans in cabled communities pay for multi-channel (4 to 12 channel) commercial cable service.

If it is possible to get more service per dollar from commercial satellite program suppliers, can the state take advantage of the situation and still ensure service to everyone in an equitable manner?

One answer may lie in assisting communities to develop and finance their own television reception and distribution facilities. The possibility of locally owned and operated television systems was demonstrated by a small (population 400) logging community in southeast Alaska which, having despaired of receiving state service or desiring more than the state system would provide, formed a nonprofit organization to raise funds and purchase an earth station and cable distribution system. Residents of that community now are enjoying five channels of television at a member cost of $200 per year. Since then at least one other community has, using a combination of municipal funds and prepaid subscriptions, installed its own earth station and cable system, and is operating at subscriber costs that are comparable to those paid by subscribers in larger communities where commercial cable systems are economically viable.

There are many places in Alaska where a local cable system would not be practical because of weather, dispersal of residents, lack of poles, permanently frozen ground, or lack of maintenance skills. However, cable systems are not necessarily the only possible means of multi-channel distribution. The state has for several years been employing low-power TV transmitters for local distribution. Employing low power TV transmitters for multi-channel distribution amounts to the substitution of power amplifiers and transmit antennas for outside cable plant. How rights to distribute programs intended for cable systems can be secured for over-the-air transmission has yet to be addressed; scrambling or some other pay TV techniques might be employed.

Funding television service at the local level and allowing local communities to make their own decisions on what services they want from those available commercially would probably not reduce the total expenditures, regardless of source, for television services, but would provide more service (program options) per dollar spent, and would eliminate the need for state personnel to be directly involved in operation and maintenance of a system providing essentially entertainment television.

The conclusions drawn from the comparison between service costs of commercially supplied programming and a dedicated state system are not the only factors to be considered in planning the future of the state's role in television services. Alaskans, probably because of their isolation, are very interested in the politics and news of their own state. The TVP provides daily state news programs, weather reports, and, when the legislature is in session, daily reports of legislative activity. These are services Alaskans would not like to give up even in return for access to a greater variety of non-Alaska programming.

If a method for encouraging communities to develop their own systems, or for private companies to provide service, could be worked out, some communities still would be unable to participate without full state support.

These are just a few of the considerations with which state planners must wrestle before making recommendations on the state's future role in the provision of television service to its citizens. The TVP has been enormously successful in terms of its acceptance by rural residents and commercial broadcast audiences. At the time it was conceived, the system as instituted was seen as the most direct, and in fact the only way, to provide a needed service. The question now is: Should the state continue to expand a dedicated satellite distribution system serving less than 500,000 people in the face of existing systems with revenue bases counted in millions and the possibility of newer services such as direct broadcast satellites just over the horizon?

THE CULTURAL IMPACT OF TELEVISION IN ALASKA

Douglas G. McConnell
University of Alaska
Arctic Environmental Information and Data Center
Anchorage, Alaska

1. Abstract

Television has come to rural Alaska during the past decade. The State of Alaska has paid the bill. Eskimo, Aleut, Tlingit, Athabaskan, and other people have joined "the global village." Can cultural diversity survive television? Does the State of Alaska have obligations and opportunities to help traditional cultures adjust to and make use of television? The following paper addresses these questions.

AUTHOR'S NOTE

In the summer of 1981, public television stations KPBS in San Diego and KAKM in Anchorage, and the University of Alaska's Arctic Environmental Information and Data Center (AEIDC) agreed to co-produce a thirty-minute film documentary on the cultural impacts of television in rural Alaska. The film will be broadcast in 1982 by the Public Broadcasting System (PBS) as part of KPBS' science policy series, SYNTHESIS.

The film will examine how the people of rural Alaska are adapting to the new age of television, will ask if cultural diversity can survive television, and will explore ways that television production and distribution technologies might be used to strengthen traditional cultures. By viewing the responses to television of a different culture, the national PBS audience might gain new insights into its own complex relationships with the most pervasive storytelling medium of our time.

In preparing to script, shoot, and edit the film, I am, with assistance from Dr. Norma Forbes, surveying existing research on cultural adaptations to television in rural Alaska, Canada, the Pacific, and developing countries around the world. Dr. Forbes is intimately familiar with the pertinent literature, and has conducted the most recent and thorough assessments of television's effects on rural Alaska. Together, we will select, from a wide range of possibilities, a narrow focus for our short film. We are at least one month shy of knowing the most important messages to transmit. They will reveal themselves as we filter the research further and spend the requisite weeks interviewing and filming in rural Alaska.

In the meantime, I was asked to write a report of our findings for the Pacific Telecommunications Conference. I hesitate to do so. Our work is incomplete, and although I expect my knowledge to mature significantly in the weeks ahead, my experience with the subject at hand is still in its infancy. Unfortunately, those who should write this piece, Dr. Forbes, the residents of rural Alaska, and others, were unavailable this weekend. My typewriter and I, on the other hand, were free, so here we are. What follows, therefore, are not the words of authority but rather a student's midterm report. It is a tentative and inexhaustive summary of some of the lessons I have learned thus far. With my limitations now fully exposed, and with deference to those who know more, know better, and know when to leave town, I'll race swiftly and unscholastically across the coals without further apology.

OBSERVATIONS

Following is an excerpt from an interview with Dr. Norma Forbes.

> Throughout history, children of every society have learned the social norms of their culture, what one must or must not believe or do, from the adults around them: parents, teachers, and respected elders. They learned by direct instruction, by imitation, and by inference from such sources as myths and fables.
>
> The socialization process as controlled by adults within the child's immediate environment produced a tremendous variety of possible solutions to the large and small challenges of life; what to eat, when to hunt, which ways to control the behavior of others were acceptable, and what forms of government were workable. Local and regional groups could maintain their own values within the larger society and this diversity of possible available solutions to life's problems enriched and invigorated societies such as America's. Social, like biological, diversity is adaptive.
>
> Personal instruction and observation were supplemented by art and the written word. But access to the written word was for the most part controlled by adults and further restricted by the child's ability to read.
>
> With the advent of television this situation changed. Now any child or adult who can push a button or turn a dial has access to the entire range of television's output; literacy is not required. For the first time in history everyone, across all age levels, in every ethnic group and social class, is exposed to a set of symbolic messages, of myths and fables, so to speak, which originate from a very small group of people within the majority society of the United States.

Rural Alaska is about the only Alaska there is. It is vast and mostly roadless. It stretches thousands of miles from east to west and north to south, across five time zones, from temperate latitudes to the full Arctic, embracing the nation's most northern, western, and eastern locations. It is the traditional home for Eskimo, Aleut, Tlingit, Athabaskan, and other Alaska Natives. These diverse people speak several languages in addition to English. They and the Anglos who have joined them live in small towns like Barrow, Kotzebue, and Bethel, and in villages like Selawik, Unalakleet, and Angoon. Approximately 21,000 people live in rural Alaska. They call it the Bush, and it's a long way from the studios where most of the television is made.

However, during the past decade, the Bush, branch-by-branch, has been subsumed by the "global village." The annexation process has been financed by the State of Alaska, is welcomed by most residents of the Bush, and is surely irreversible. There will be no massive secession by rural Alaska from the "instant simultaneity" of the "global village." Television is there, as it is here, to stay.

Ten years ago, there was almost no television in the Bush. Now many communities of twenty-five people or more receive either one or both of the state-financed satellite channels. The Satellite Television Project, initiated in 1977, currently delivers principally commercial news, sports, and entertainment programs. The Learn Alaska system, which begins operation this fall, will provide public and instructional programs. It has been good politics to invest public money in the dissemination of television to almost everybody who wants it.

The Native cultures of Alaska, each in its own way, are in transition. Many Native people have been seeking during these past decades to adapt their old ways and values to the new realities of corporate and technological America, to blend and live within several worlds: the world of the past that linked them closely and spiritually to the land and to each other; and the world that builds cities and subsistitutes subsistence living for cash and credit economies.

Then came television. By all measures it has been a big and instant hit. Generally popular though it is, however, some people fear that television is the pied piper of the new world; that its advent may cause or at least hasten the demise of Native cultures; that the hypnotic world view which is telecommunicated from New York and Los Angeles gives us all the same stories, the same frames of reference, and finally the same (and possibly unrealistic) expectations for our lives. They worry that television is the great minimizer, and will ultimately reduce Alaska's rich cultural diversity to the lowest common denominator. Native communities will disintegrate, Native languages will be lost, oral traditions will disappear, Native people will be permanently severed from the land, and we will all be the losers. They cite studies of the cultural leveling caused by television in the Pacific, Canada, and elsewhere to justify their concerns. But the State of Alaska has spent little money to find out if their worries are warranted, and insufficient time has passed to measure the long-term consequences of television. As a result, evidence that might substantiate or refute the notion that television is a grave threat to cultural diversity is incomplete and inconclusive. Speculation and questions abound. Answers do not. However, for those who wish to encourage cultural diversity, there are both disturbing and hopeful signs.

Perhaps the most troubling are the consistent anecdotal reports that there is much less visiting in Bush communities now than there was in the years before television. According to at least one of Dr. Forbes' informants, children do not come to their elders as often as they once did to be told the old stories. The attendance at community functions, such as school board meetings, has dropped. Television might be eroding the communal interactions and storytelling upon which the sustenance of Native cultures depends. The white, urban heroes and methologies that so thoroughly dominate the television they receive might be disconnecting Native children from their ancient legends and values and, ultimately, from the land. Television, as it has been programmed in Bush Alaska, apparently accelerates the urbanization of visions and values. The majority of Native children in rural Alaska, whether or not they currently receive television, want to live somewhere other than their home village when they become adults. But Native children who have access to television want to move to more urbanized places than do children without television. For example, children from villages which do not yet have television will typically want to live in nearby towns, such as Kotzebue, when they grow up. By comparison, village children who have television will more likely dream of living in larger and more distant cities, such as Anchorage. Will they fulfill their dreams? If they do, can they ever return home? Can traditional cultures survive J.R.'s DALLAS or ARCO's Anchorage? The answers are not clear, but leaping to doomsday prognoses is clearly premature. In fact, there are some good signs.

National studies, for instance, indicate that at least a partial recovery of traditional community activities might, in time, be expected. Perhaps the social importance of television in villages will diminish somewhat as its newness fades, and the values and pursuits of the past will be given new life.

Bush Alaskans watch approximately as many hours of television as do other Americans. The program

preferences for children and adults in rural Alaska coincides with those of the rest of the United States. Bill Buckley is no match for the DUKES OF HAZARD. However, and this might be one of the brightest rays of hope for the proponents of cultural diversity, if given a choice (which they have rarely been), many Native people interviewed by Dr. Forbes indicated that they would prefer to watch programs about local topics. Whether this is true or not can't be proven easily because the state has been more interested in building earth stations and renting transponders than in funding the production and distribution of programs by, for, and about Native people and cultures. Almost every program most village people have ever seen has come, stocked with commercials, from somewhere else. But this may be changing. Through the State Department of Education, the University of Alaska, and regional school districts, localized programs are now being developed. The medium might yet communicate new messages. A new form of community life and visiting, for instance, might be stimulated and nourished by television. The old stories might be reincarnated electronically. The Noatak/Noorvik basketball game might be televised opposite the Superbowl, and win the ratings race in Northwest Alaska. Urban attitudes might be softened and accommodated to rural Alaska with the help of television. The blending of several cultures on television might be achieved. Might. Maybe. No one knows for sure. The work has just begun. A sustained public commitment to provide Native cultures a telecommunicable voice might make a difference.

There are other grounds for optimism as well. People are adaptive; they are not simply passive recipients of television. They can manipulate its messages, in part, to meet their own needs. Change is everpresent, and Native cultures have proven themselves to be strong and resilent. They have adjusted to many threats and have survived for thousands of years. Television might be just one more surmountable challenge, less significant than many others.

In the final analysis, if things get too bad, some argue that television sets, one by one, can always be turned off. True enough. But then I'm reminded of what oldtime race driver Barney Oldfield was reported to have answered when asked why he did not have brakes on his car: "Cars," he said, "are made to go, not stop."

He could have said the same thing about television. Television sets are expensive pieces of furniture, and they look best when they have pictures on their screens, moving, changing colors, and making sounds. So people turn them on and leave them on for hours and hours every day. In Boston, Boise, and Bethel they do it; Irish, Chicano, and Eskimo, we all like television. In America, the television sleeps only when we do. It is a mixed blessing for all of us, but it isn't going away. We should try to understand it; how it works and what it does to us. If we don't like all that we find out, we should make adjustments, try to take some control, and make television work for us. For most people in most places that's not easy. But the State of Alaska, as the prime financier, has a special obligation to understand the social and cultural consequences of the television it is providing. As the wealthiest state in the nation, it also has a unique opportunity to help its diverse people and cultures make adjustments, take some control, and make television work for them.

COMMUNITY LIAISON

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Abstract

As the State of Alaska continues to develop a comprehensive telecommunications plan for the 1980's and beyond, satellite television delivery continues to hold a vast interest for the rural residents of the state as well as that of the legislators. This paper presents a "bush bureaucrat's" approach to community liaison and working with village governing bodies and rural residents.

Alaska 's big. In fact Alaska is real big. The geographic boundries of the state include 33,904 miles of tidal shoreline (including 1,800 named islands) and 1,538 miles of Alaskan/ Canadian border. The state is bordered to the south by the north Pacific Ocean, to the west by the Bering Sea, to the northwest by the Chukchi Sea, to the north by the Arctic Ocean, to the northeast by the Beaufort Sea and to the east by Canada's Northwest Territory and British Columbia. The state contains over 586,000 square miles, over 3,000,000 lakes (of which only 94 are greater than 10 square surface miles) and 28,000 square miles of ice fields. From north to south the state measures 1,420 miles and from east to west 2,400 miles.

Despite of its size, Alaska has only a little over 400,000 residents. The vast majority of the residents live in Anchorage (roughly 200,000), Fairbanks, Juneau and Ketchikan. About one-quarter of the population lives in smaller towns spread through south central and southeastern Alaska. The remaining one-quarter of the residents live in the "bush" amoung the regional centers and the villages.

From one community to the next, lifestyles vary. People live in everything from condominiums to trapper cabins to boats to government housing. And people seem to get around whether it requires firing up a snow machine in the winter, hoisting a sail in the summer or cranking over the family car year around. But to really get around one needs a few dollars of cash in pocket and an air ticket to jump the local mail flight from a village into the regional center and to clear the security line at the municipal airport for a 30,000' cruise into the "city" or out to the "lower-48". However, travel is not the only way people of varied backgrounds are brought together.

More than anything else to tie Alaskans to Alaskans, the development of communications statewide has provided the major link. Statewide communications has tied Alaska to the lower-48 and the rest of the world. However, phone systems have not been the only communications link available. Since 1976 the State has embarked upon a course of providing rural residents with sameday television from the east and west coasts as well as from Alaskan cities. This television service has become one of the most widely requested services from out lying communities.

TELEVISION

Today, approximately 70% of the residents of Alaska receive one form or another of commercial television simply because they live in the cities or regional centers with commercial broadcast stations and/or cable television systems. The remaining 30% include the 287 rural communities and villages of which 223 communities will be receiving two channels of statewide television and an additional 41 communities will be receiving one channel of television provided by the State, by 1983. By the end of the current fiscal year approximately 10% of the population will not have access to either commercial or State provided television services. Needless to say, based upon the State's track record, most of the unserved communities will probably be receiving satellite television services in the next few years.

THE BUSH BUREAUCRAT

In essence, the bush bureaucrat is one who spends considerable time piloting a desk in the home office as well as traveling throughout the bush conducting business on behalf of the home office. As a rule, "Bush Bureaucrat" is a self-endowed title as one will never find it printed on a business card under Joe Bitscoe. Nonetheless, the bush bureaucrat is one who works closely between the two separate worlds of the village governing body and the home office. The individual will attempt to accomplish the goals and/or objectives required of the job while on someone else's turf and with the least amount of frustration possible.

The key to successful field trips, as in so many other areas, is good, solid planning and a teaspoon or two of patience. The planning activities assist one with getting every aspect of the trip together into a cohesive mental package and it all begins while piloting the trusty ol' desk in the home office. The patience aspect of traveling comes into the plan consistently whether trying to get through

to a single bush phone community or trying to get from one community to the next due to an aircraft that never arrived and you begin to ask yourself "what's what and why is it that way?"

PLANNING

Planning a trip can be rather easy if one has only a village or two to visit. However, the planning process obtains a rather complicated aura when one has twenty-five villages to visit in five weeks and the rough itinerary covers 4,000 air and land miles in the midst of winter. After a few years of bush travel I have finally come up with a system that seems to work fairly well which, as a rule, has returned me to the home office almost as refreshed as the day I departed. These planning steps basically include: 1) understanding the job assignment; 2) research; 3) contacts; 4) itinerary; 5) second contact; 6) travel; 7) meeting; and 8) follow up. To illustrate the typical routine for a bush bureaucrat about to commence on a lengthy sojourn, assume one is to visit 15 villages in three weeks and the goal is to arrange for power and space arrangements required for the installation of television receive-only small earth stations and low power television transmitters. Arranging the task can be easy with sound preparation.

PREPARATION

Preparing for a business trip into the field and rural villages allows for more than just packing and climbing aboard the next flight out to the destination. First one needs to understand exactly what is required of the trip, what will be accomplished and what the final outcome will be. Understanding the job assignment is one of the most important single factors involved in working with village governing bodies. People are sharp and the creditability of your office and your ability to accomplish the job falls in great part on understanding the job in detail. If one is about to take on a new job assignment in an area one is not totally familiar with, then make sure what is involved. Remember the foot and mouth you may save will likely be your own. In addition, it is important to understand the implications of the service one may be providing the community (e.g. how might the delivery of real-time television affect the community). Understanding the job assignment, it's ensuing details, what is to be accomplished and how it may ultimately affect the daily lives of the local residents should not be understated. There are naturally embarassing moments in ones' life, but few match that of a representative of state government stumbling around for answers in front of a village council meeting while council members share lovingly abusive jokes, in their own language, about the outsider.

Research can always be a bit dry, especially into areas of little interest. But to research a community one is about to visit can be as enjoyable as it is informative. As one would benefit by researching a job to be accomplished, one will certainly benefit from preparing a little and knowing something about the village to be visited. First get a good topographical map and check the place out. Notice key geographic features, nearby communities and the general layout of the land. Check around with other bush bureaucrats who may have been to the community recently. Find out something about the people, their customs and whether or not English is the first or second language (I once landed in a remote western village in the middle of winter and had to wander around for 30 minutes before anyone would talk to me in English and when they found out I was the TV man no one left me alone for the rest of the visit). Find out what type of governing body you may be dealing with (in Alaska there are five different types of local governing bodies) and which has local control. Get some information on the local economy, whether it is a subsistence or cash economy. Find out how far the air strip is from the community - it could be a long and arduous walk in case a snow machine does not meet you at the strip. Essentially, the more one knows about the community to be visited the more comfortable one will be in unfamiliar surroundings. In addition, some local knowledge provides the opportunity for interesting conversations and friendships. A final word on researching a community, be sure to find out if there is local overnight lodging, a general store and a commercial eating establishment.

Before one flies into a community, be more than sure that you are expected and that the local residents have some idea as to why the stranger is in town, in the middle of a blizzard, stumbling around between dog teams and snow drifts. Make verbal and written contact with those you are to meet with. I always make a phone call to the community council president, explain the program I am working on and request that I come out to discuss the program in detail. I set up a tentative meeting date, request the participation of other village council members and the community at large, if applicable. Next I drop a letter into the mail which explains the program in more detail and confirming tentative meeting dates. Making such contacts is very important. If the contact is not made, often business will not be accomplished as the persons you need to meet with are out hunting, fishing or are in another community on other business. Phone those you want to meet with and follow up in writing.

When traveling in Alaska, it always helps to have a rough itinerary. An itinerary will not always go on schedule, but it will be a day or two in line with those one needs to meet with. Weather always is a predominant factor in getting around. Availability of aircraft in regional centers is not a problem as a rule, but equipment does break down and one can be aided greatly with the

teaspoon or two of patience mentioned earlier. I set up a rough itinerary based on geographic considerations and some logic. I try not to cross the same path twice and to keep air time to a minimum. This planning also gives a reasonable time frame as to when I will be in a particular village and I inform the village contact accordingly. After the rough itinerary is laid out, it is time to get back in touch with the village contact. Let the individual know when you expect to be arriving, how you are arriving and who may be travelling with you. Again review what it is that you want to be discussing with the village council and request that other village decision makers be present. If the air strip is some distance from the community, ask if any form of transportation is available, and if not, if a ride into town can be arranged. If you are having a difficult time getting through on the phone, which is not unusual in single phone communities, use the regional center radio station (usually a public radio broadcast station) to send a message to whomever, wherever, with your information. The radio is on in each household and establishment in a village as it is the main source of information, news and entertainment. Always make the second contact. One does not want to solely depend on a conversation and letter communicated three weeks earlier. It is an unproductive day when the meeting never falls into place and all one had was a grand time sightseeing.

As a part of your research into preparing for the extended bush trip, you will have figured out what air service is available into the various communities on your itinerary. Often a bi-weekly mail flight will have room aboard or you will need to charter out of a regional center into the village. As with all air travel, reservations are required and your itinerary is your guide as to dates and times. If one is working along the highway system, then the car is convenient and allows more flexibility with departing and arriving dates and times. Always allow yourself extra time because it is easy enough to have nature working agains you (and remember she often prevails). At other times, other modes of transportation will be more accomodating such as the marine ferry system or a small boat for a trip across the lake from one community to another. If travel costs are a concern, be sure to know how much it will cost to charter versus catching the mail flight. As a rule, a book of travel authorizations is as good as cash and they are much more convenient. Do not forget the camera.

Travel light. You will know what to take for the job, but do not be too concerned with clothing other than what is required for weather. Suitcases are out, small packs are in. A small pack can easily be carried around, stows well in a small plane and is considerably easier to handle than a bulky suitcase. As a rule of thumb I carry two packs. One day pack and one slightly larger traveling pack. For day trips out I take the day pack with the tools of my trade in it plus a sleeping bag (you never know when you may be left in a village overnight) and a tooth brush. The slightly larger pack carries a change of clothing plus has room for my day pack and sleeping bag. Nothing is fashionable to wear in a village but practical clothing and an extra sweater. Do not worry about changing clothes often as showers are few and far between. Once a week you may be in a regional center where you'll find a laundry facility. Remember, when you are in the village you want to be comfortable and you want those whom you are working with to be comfortable. A three-piece suit belongs only in the city with other three-piecers.

MEETING

Meeting in the village with the local governing body is the reason for the whole trip. You will want the meeting to be as smooth and enjoyable as the entire trip should be. One bad meeting will effect each and every meeting left on your agenda. So the best piece of advise I have come to know on my village travels is to be patient and relaxed at the meeting. Remember, what you have been accomplishing during each village visit is new to the particular village you are in at the moment. What may eventually become old to you is new to the village.

I have found that village meetings seem to be drawn out. This is simple because the local governing body wants to consider everything you have to say and weight it out for their people. Do not rush through a presentation. Be slow and methodical. Use aids if they are available. Often I will have a hand-out that explains the program such as Figure 1. A graphic aid can say a thousand words at a glance. Do not get into the heavy bureaucratic mumbo-jumbo one might use in the office. Rather, explain things as they apply to the local community. A presentation works fairly well if one first explains the project in general. A question and answer session is the best way to work through the particulars and often more is said in meaningful terms during the question and answer session.

When the State of Alaska receives an appropriation to place a television receive-only small earth station and a low power television transmitter in a community, I find out right away if the community is interested in having the service. At the council meeting I explain the service and project, what the State will provide and what is expected of the local community. I explain the enabling legislation, the type of television programming to be available and the time frame for the programming to be on the air. I explain how a satellite-based television distribution system works from the head end down to the consumer receiving it in the home. People like explanations that make sense. Make a presentation work by making it make sense. It's simple enough to do if one slows down and looks at the service from the village point of view. Use local points

of interest as illustrations to get concepts across and people will better understand what is being said.

Two important items to remember when working with a village council: 1) do not be tart and over-bearing (i.e. presumptuous); be considerate and polite; and 2) remember you are in the community to provide them with a service and that you are on their turf so act accordingly.

Usually after the meeting a field survey is conducted with a village council member to find the most suitable location for the equipment placement. I often will also meet the village school class to explain, with the aid of a blackboard, the nature of satellite television distribution. Goodwill in a village goes a long way towards establishing future working relationships, friendships, and leaves a better taste for other "outsiders" coming into the community later.

A couple of points may be helpful here if one plans on spending the night in a community. Lodging in rural communities is limited. Often one will sleep in the health clinic, in the school or a back room of the community building. If one spends that evening in the village, get out and get around. Talk with people. It is appreciated. If lodging is not to be found and you are offered a night in a family's house, take it. Eat with the family and help with any chores. Offer a payment for the lodging just as you would in a hotel. If refused, ship out a box of fresh produce and a thank you note when you get home. It is the thought that is appreciated and the sincerity of the consideration. In my travels around the state I have found people to be friendly and always interesting. People enjoy sharing and much can be learned about our rural neighbors by spending time with them and appreciating what they have as compared to what we urban residents do not.

FOLLOW UP

One of the final steps in working with rural villages and governing bodies is to follow up a meeting with a letter. The letter needs to state the arrangements mutually agreed upon and conclude any unfinished business. A thank you is also appropriate for the hospitality and success of the meeting. I often make room for a follow up phone conversation and an offer to provide any assistance or trouble shooting that may be required. Often a village council president will call upon you for related matters and any assistance you may render will be greatly appreciated by someone removed form state offices by hundreds of miles.

IN CONCLUSION

Working with rural governing bodies and village residents can be very rewarding. The work will not be too difficult if one follows a simple set of prescribed procedures and planning field trips in reasonable detail. Important items to remember include:

1) Understanding the job assignment to be accomplished in detail;

2) researching the local community to have a better understanding of it and its residents as well as knowing what facilities it does or does not have;

3) establish village contacts early and keep them abreast of the program or services being offered using both the phone and letters;

4) establish an itinerary for travel including schedules of flights and meeting times, but allow some flexibility for unforseen delays;

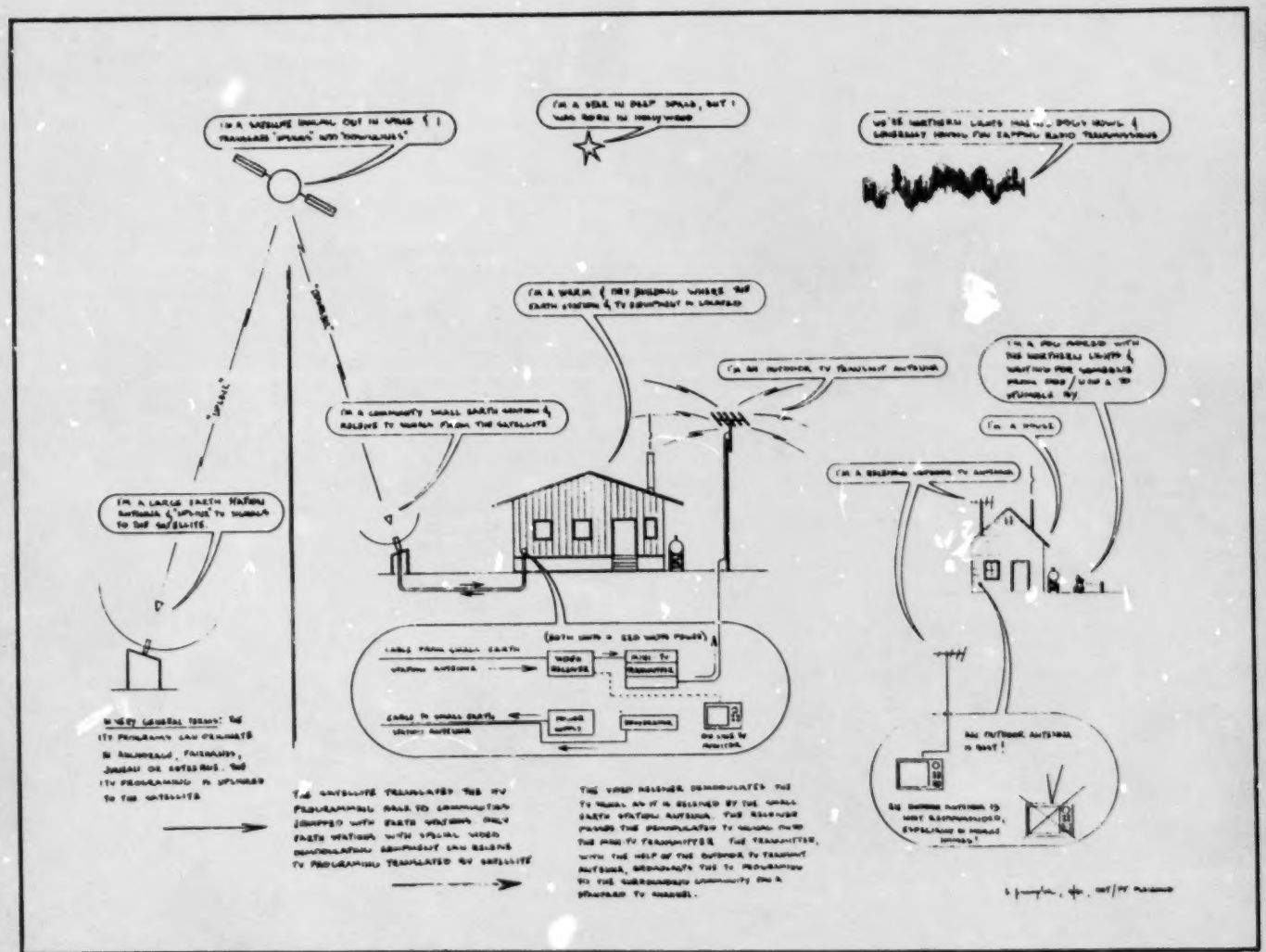
5) contact the village contact before arriving so that those you are to meet with can be prepared and ready for the meeting;

6) enjoy your trip to the community and do not forget the camera;

7) conduct the meeting at a comfortable pace with consideration toward being an outsider on someone elses turf; and,

8) always follow up the meeting with a letter or phone call or both.

One final comment is due regarding sightseeing. Sightseeing is one of the side benefits when traveling in Alaska on business as one cannot help but see so much that is new and beautiful. Remember that nature is one thing and that people are human. When flying around with the ol' 35 mm strapped around the neck enjoy shooting nature at her finest. However, do not invade the privacy of rural residents by photographing them at home in the village doing what they may consider to be everyday chores (e. g. cleaning a walrus, skinning a caribou or staking out fish to dry) without permission. I often wonder what the suburban housewife would think if a tourist leaped over her back yard fence to snap a picture of her hanging her wash out to dry sporting a bathrobe and curlers. . .



Graphic by Bob Frampton, Department of Administration, Telecommunications Services.

Figure 1

COMMERCIAL TELEVISION IN ALASKA

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1. Abstract

Commercial television in Alaska is an extraordinarily expensive, unique system serving a widely scattered populace and is in no way comparable with commercial television in the "Lower 48."

Alaska television broadcasters are in a class by themselves, in an remote, distant and often inaccessible land. How programming is received is only one of the many problems faced by Alaskan broadcasters.

The ABC affiliate in Alaska, KIMO Television, receives its programming on a one-week delay, via its own delay center in Seattle, Washington. Programs are received off-air and recorded at the Seattle facility, then forwarded by air to Anchorage. CBS and NBC programs are delayed two to three weeks and received via tapes bicycled from Hawaii.

These systems of delayed broadcasts of network programming are very costly to Alaskan broadcasters. Alternative satellite programming at the present time is economically not feasible, but is the hope of the future.

The only live satellite programming available to Alaskans on a regular basis is through the State of Alaska Satellite Television Project. Satellite time is made available through this project, to air "live" sporting events and major news events, daily network news, some daily programs, and some specials. The three network affiliates take turns providing these programs to the satellite system.

Alaskans depend on television for much of their information, news and entertainment; this is especially true in remote villages which are not served by newspapers and/or radio. Today, Eskimos of Anaktuvuk Pass, which has a population of 195, can see programs such as "ABC World News Tonight." which link them to the outside world. This phenomenon is changing their culture and shaping their thinking.

The significant growth of Alaska has brought tremendous pressure to bear on commercial broadcasters, to increase their service to Alaskan viewers. Broadcasters are investing in newer, state-of-the-art equipment, in their quest for total professionalism on a par with broadcasting in the contiguous United States. A strong commitment to news and public affairs is resulting in bigger and better news teams and a dedicated effort to inform and instruct, as well as entertain.

Commercial broadcasters in Alaska have brought television to its citizens under highly contrary and adverse conditions, unknown to their "Lower 48" counterparts; they are justly proud of their achievements, and look to the promise and possibilities of the future.

The Alaska frontier is the last frontier and is slowly giving way to increased population with attendant problems, needs and demands. Alaska television broadcasters will continue to meet these challenges with the same spirit, enthusiasm and "can do" attitude that brought commercial television to the State in the first place - despite all obstacles.

A closer look at the fabric of commercial television in Alaska reveals some startling differences from most other television markets, e.g.: Alaska broadcasting has some commonality with the State of Hawaii television broadcasting. Specifically, there are only six network affiliates in the entire State of Alaska. These are the primary affiliates for CBS and NBC in the cities of Anchorage and Fairbanks, and the State's only primary affiliate for ABC in Anchorage, KIMO TV. The only commercial television station in Juneau is the NBC affiliate.

To further illustrate the unique pioneer aspects of commercial television broadcasting on the last frontier, a look at some historic dates is in order.

.The first Alaskan television broadcast began December 11, 1953.
.The first color television - June 18, 1966.
.The first live satellite broadcast

July, 1969 (Apollo Moonwalk).
.The first live satellite football telecast - January, 1970.
.The first FCC licensing of mini transmitters - 1974 (Alaska pipeline camps).
.The first satellite telecast of network news - April, 1976.
.Initiation of the State of Alaska Satellite service - January, 1977, incorporating all three networks through Anchorage primary affiliates into one channel TV for rural-bush communities, including most news, sports and specials.

In Alaska, commercial television has had to reach the most remote and underpopulated communities in the entire United States, overcoming such obstacles as being distant and removed from the continental United States by several thousand miles and attempting to reach extremely small numbers of population in vastly separated areas across the State.

ALASKA'S ECONOMIC PROFILE:

Alaska is not only a geographic frontier but is a frontier for individuals and a frontier for business. It is a vibrant and confident home for people and for new ideas. Its citizens are accustomed to challenge and to change, and to innovative approaches to making our free enterprise system work - for all its people. Alaska's phenomenal growth symbolizes its explosive and restless energy and demonstrates the determination of its business community to find new and more efficient ways of serving Alaska and its citizens.

Alaska is one of those states where profit has meant growth, and growth has meant competition. Its people know well that profit means opportunity - opportunity for expansion - for new jobs - and for creation of a better life. The evidence is abundant that Alaska is indeed building for a bright future.

Alaska is huge - one-fifth the size of the continental United States. It spans four time zones, and has a coastline which exceeds that of the entire "Lower 48." If you live in Adak, you are as close to Tokyo as to Seattle. Yet within this vast geographic area live only 400,000 people. And most of these are concentrated in the State's major urban areas. Anchorage, with 54% of the State's population is the recognized center for commerce and industry. Fairbanks and Juneau follow Anchorage in size, with 15% and 5% respectively. Thus, these three areas contain approximately three-fourths of the State's total population. By slicing the pie somewhat differently we get yet another picture. The so-called "rail belt" area, that portion of the State served by the Alaska Railroad, bounded on the north by Fairbanks and to the south by Seward, contains roughly 73% of the State's total population, giving ample testimony to the value of transportation and its proximity to development.

Alaska is a young state. With a median age of 26, Alaska is second only to Utah as America's youngest state.

As a leader in oil production for the United States, Alaska has become America's energy storehouse. But the potential appears to be even greater and Alaska's energy community continues to grow. But so too, are nearly all aspects of its business community.

Alaska's distributive industries now supply 44% of all Alaska jobs and is Alaska's #1 employer, recently passing government (including military), the long time leader. This augers well for our State's future, for diversity of Alaska's business gives our State a firm and broad foundation with which to help resist future swings of the economic pendulum which can and do occur in a single industry economy.

Aided by State oil revenues, Alaska is now on an economic upswing which is expected to last for some time. Because of this upswing, because of the favorable reception afforded to new business development, executives of companies in the "Lower 48" states are becoming more and more interested in "the last frontier."

I should now like to give you a very brief summary of our State's economy and its components.

The number one industry in Alaska is, of course, petroleum. North Slope oil production now flows through the trans-Alaska pipeline at the rate of 1.5 million barrels a day, supplying a significant amount of the nation's oil needs. In addition, the Prudhoe Bay field has 10% of the nation's known recoverable reserves of natural gas. Our well known pipeline, however, serves but one of the producing geological basins within the State. Several more south of Anchorage, both on and off shore, have been producing for many years. But of more importance to America's energy needs is that there are eleven more similar geological

basins in the State, and they have yet to be explored.

Alaska's number two industry is tourism. In 1980 there were more than five hundred fifty thousand visitors to Alaska with a 15% increase forecasted for 1981.

With Alaska dependent on the "lower 48" states for most of its consumer and business supplies, the State has a growing and unique transportation system. The Port of Anchorage, completed in 1961, is served by both Sealand Service and Totem Ocean Trailer Express, with an average of twenty to thirty thousands tons per trip of retail commercial and private cargo. Sealand also serves the port of Kodiak. Southeast Alaska points are served by Foss Alaska Lines. The Port of Valdez, as the debarkation point for Prudhoe Bay oil, already is the State's largest port in terms of total tonnage and recently broke ground on a new forty-eight million dollar port facility.

With long distances and untracked wilderness, Alaska has this nation's only federally owned railroad, serving the thriving land system between Fairbanks and Anchorage and the Kenai Peninsula. Further expansion of the railroad is critical if Alaska's vast interior is to be properly served. Alaska has a mix of transportation services and needs found nowhere else in the country.

One air freight company serves the State from points south and another two provide intra-state service. There are ten-thousand four hundred and four certified pilots, flying seven thousand one hundred and four small planes... the highest per capita figure in the nation. More than two thousand five hundred of those aviators are commercial pilots. When thirty seven airlines use Anchorage International Airport, it is a small wonder that the city calls itself the air crossroads of the world.

No one living in Alaska during the great earthquake of 1964 will ever forget the dramatic lifesaving role played by the military. Today, some twenty-three thousand, six-hundred and fifty active duty military personnel man thirty active bases in this State. These service personnel in turn have more than forty-thousand dependents. Civil Service supporting personnel number four-thousand six hundred and twenty, with another two thousand engaged in various military support areas. Major bases are found in Anchorage and Fairbanks.

Surprisingly, for a State thought (erroneously so by many), as the frozen north, Alaska has an agricultural history dating back to the great depression, when a large number of mid-western farmers were transplanted to the rich Matanuska Valley, north of Anchorage.

The State is presently opening up fifty-thousand additional acres of farm land near Fairbanks. Similar efforts for dairy farming are in the planning stages northwest of Anchorage.

Alaska is famous for its gold rush days, and the rush is on again. High prices have generated a resurgence of interest in that metal. A molybdenum discovery in Southeast Alaska is one of the largest in the world. There is a virtual mountain of copper in the Wrangle Mountains and a mountain of jade in western Alaska. Deposits of tin, zinc, lead and silver are no less superlative. The ability of our State's coal deposits to supply our nation's future needs is not measureed in years or decades, but centuries.

Alaska has a rich fishing heritage. With a two-hundred mile limit, fully enforced, that history is assured of a bright future. The thirty-one thousand, nine-hundred and sixty three State fishing permits were fished in 1980 by eighteen-thousand, seven-hundred, sixty one Alaskan fishermen supplying some six-hundred, in-State processors. In addition to the traditional fisheries for crab, shrimp, salmon, cod and halibut, Alaskan fishermen are ready to tap the vast potential of the bottom fish resource.

When construction of the world's largest privately financed project, the trans-Alaska oil pipeline ended in 1977, it was not surprising to see the construction and real estate industry slump. But that was four years ago. Today, our economy is healthy and as stated earlier, more diversified. Hopefully, we learned our lesson. Our State Legislature appropriated $490 million for fiscal 1981, plus $520 million in supplemental appropriations from fiscal 1980 for capital projects.

Public works projects set records in 1980 and were broken in 1981. A thirty-million dollar plus study currently is under way on a planned multi-billion dollar hydro-electric project between Anchorage and Fairbanks.

The Alaska economy is well down the road toward continuing improvement, with most industries experiencing employment

increased in 1981. If several large energy related projects proceed on schedule, an even stronger reacceleration of Alaska's economy is expected in 1982.

COMMERCIAL TELEVISION'S FUTURE IN ALASKA:

The future of commercial television in Alaska will primarily follow, though belatedly, the pattern of change affecting television across the United States. This time of change for commercial television in the United States is embodied in many legal, economical and technological changes.

The largest single element of these changes is the extraordinary and rapid development of the use of satellites. Alaska, like Hawaii and others, will benefit dramatically with this satellite use explosion. The timing of this phenomenal increase in the use of satellites is at hand now. Specifically, it is now confirmed that all three networks, ABC, NBC and CBS, have contracted or are intending to contract, current and future satellites for the delivery of network programming to their affiliates nationwide - and worldwide.

NBC, at this time, with its parent company, RCA, appears to be leading the way into the satellite era. Reports abound of the new COMSTAR satellites being a part of those employed for this change in network program distribution.

Alaska, even more than Hawaii, continually falls into the "international" category of television distribution. The ramifications of satellite coverage to Alaska's commercial stations is being studied intently at this time, with several proposals for satellite earth stations being considered and many of the beginnings to take place in 1982.

Alaska's people for the first time will experience the full impact of being tied to the "mainstream" television fare of the people of the "lower 48" states. The largest single impact to Alaska of the satellite delivery, has been already muted by the tremendous success of the Alaska State Satellite System's success in bringing news, public affairs and sports to its citizens.

Alaska, with its four time zones, will likely always have to contend with a tape delay center concept, wherein the established programming patterns of commercial television will continue as they have in the past - but be greatly enhanced by the same-day time zone delay of satellite network and syndicated programming. This would be especially true of seasonal specials and news specials and documentaries, and some sporting events.

The current State Satellite System has been a very positive example of extraordinary cooperation between network affiliates, public affiliates and the State-financed satellite distribution system funneled into one channel service to almost 100 communities in the State of Alaska. This single channel service, currently proposed to be expanded into several channels of television to all of these communities in Alaska, through the State-financed satellite system, is such that ultimately bush communities with small populations will have the opportunity for viewing choices, as is the case in urban communities.

Additionally, timely informational programming that is currently not carried on the State Satellite System, such as "This Week with David Brinkley," would under the new network satellite program distribution system, likely be carried in the urban areas and also be offered to the intra-State satellite system for rural and statewide viewers.

Alaska is a young state, with most industries also being young in development and commercial television in Alaska is no different. There have been more improvements and changes in the last half-dozen years than in the previous dozen years, and this accelerated expansion and development of commercial television in Alaska seems destined to continue. Thus, the philosophy of Alaska being the last frontier also applies to commercial television development in Alaska. It is predicted that Alaska will take its rightful place as a fully-developed state in these fifty United States.

Having begun to overcome the difficulties of remoteness, small population, and the last state to develop, Alaskans now have the opportunity to improve on and perhaps lead the way in development and progress in the communications industry and in commercial television in particular.

The eyes of the world are on our magnificent State as it meets the challenges of change and progress with the true "spirit of Alaska" that is in the hearts of all its people.

CABLE TELEVISION IN ALASKA

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Abstract

The state's huge size and small, widely dispersed population dictate a uniquely important role for modern telecommunications in Alaska. Since being deregulated in 1979, Alaska's cable television companies have continued to improve the quality of services they provide. Soon, more than 90% of Alaska's people will have access to cable television.

Electronic communications play a special role in Alaska, where vast, unpopulated distances separate communities and where satellite communication has become common-place. According to Lt. Governor Terry Miller, Alaska's "diseconomy of scale" suggests that telecommunications will continue to play an important role in the state's future. Says Miller, "We're a state of small towns and villages scattered over an entire subcontinent. The expanses involved are awesome, and because of our different economic bases and our different cultures, there's a strong tendancy toward fierce regionalism on all sorts of issues. So Alaska has some unique problems, and telecommunications is the key to bringing Alaskans closer together."

When Anchorage's cable system is complete in 1984, more than 90% of Alaska's people will have access to cable TV, a percentage far higher than in any other state. Since Alaska's state legislature followed the national trend by deregulating the cable industry in 1980, the quality of cable service within the state has continued to improve. A number of different companies provide service in Alaskan communities, including the following:

Alaska Cablevision Incorporated

With a total subscribership of approximately 6,000, ACI serves Petersburg, Wrangell, Cordova, Kodiak, Valdez, Nome, and Kotzebue. After acquiring its seven Alaskan cable systems from North Star Communications in 1980, ACI launched a half-million-dollar program to upgrade old equipment and install new earth stations and cable. Each of the seven systems has been increased from four or five channels to 12, and brought up to modern standards as well.

Kodiak provides a typical example of the improvements ACI has instituted. Formerly a five-channel system, Kodiak Cablevision now offers a dozen channels - including Home Box Office, Entertainment and Sports Programming Network, USA Network, WGN Chicago, WTBS Atlanta, Cable News Network, Alaska's "State" satellite channel, and channels devoted to Kodiak Community College programming, local information, and commercial network programming from Seattle.

Alaska Cablevision Incorporated, an independent company, is a venture of Rock Associates - a group of five working partners operating cable systems in California, Montana, Colorado, Idaho, and New Mexico, in addition to Alaska.

B.C. Cable

B.C. Cable is a locally-owned, independent company serving Alaska's capital city of Juneau. The era of satellite-transmitted cable programming in Alaska began when B.C. became the first cable system to install its own earth station, in 1977.

In September, 1980, B.C. Cable expanded and completely re-organized its service, effectively doubling the amount of programming available to subscribers on its 12-channel system.

Four new full-time programming sources were added at that time: Cable News Network, WOR New York, WGN Chicago, and Entertainment and Sports Programming Network. In addition, C-Span - which televises live debate from the U.S. House of Representatives and other public affairs programming - was added on a part-time basis.

The new programming joined a line-up which includes entertainment and educational programs from the "State Satellite," the Christian Broadcasting Network, educational programming from the Appalachian Community Service Network, Home Box Office, WTBS Atlanta, PBS, Nickelodeon children's programming, KTNY Juneau (NBC), and taped ABC and CBS programming originating in Seattle.

In 1981, B.C. Cable installed a second earth station, adding five more channels of premium

programming. B.C. Cable serves approximately 5,000 subscribers, representing more than 90% of the households in Juneau.

Bethel Cablevision

The approximately 800 subscribers in the Bethel area give this independent, locally-owned cable system 75% market penetration. The recent installation of a new earth station means the availability of 12 channels instead of five.

In December, 1980, Bethel Cablevision became the first cable system in Alaska to offer radio programming from a distant station - Anchorage's KBYR - heard 24 hours each day via Alascom satellite. The same satellite hook-up allows coverage of the Kuskokwim 300 Sled Dog Race to be transmitted from Bethel to the rest of the state.

Due to the overwhelmingly positive response to the introduction of KBYR, confirmed in a survey of subscribers, Bethel Cablevision is looking into the possibility of adding several additional distant radio stations.

McCaw Communications

McCaw first entered the cable television business in 1952 in Washington state. Now serving more than 30,000 subscribers in Washington and Alaska, McCaw is also involved in Alaska's radio common carrier business. Alaskan communities in which McCaw Communications provides cable TV service are Fairbanks, Ketchikan, and Sitka.

In Fairbanks, McCaw competed against four other companies for the right to build a cable system ideally suited for growth and expansion. The system has full 35-channel capacity and boasts two-way capability as well. A second earth station was recently installed in Fairbanks, giving the system the ability to access additional satellites for special events and other new programming.

Local news coverage is among the services provided by McCaw in Ketchikan and Sitka, where the company operates systems with 20-channel capability. In both communities, two-way sections will soon be added, and the company is studying the feasibility of installing new earth stations to bring in additional channels of satellite programming.

MultiVisions

On September 21, 1979, the Alaska Public Utilities Commission selected MultiVisions over three other applicants to build a 650-mile cable system for Anchorage, Eagle River and Chugiak. MultiVisions is an extension of VISIONS, the single-channel pay TV company which has been serving Anchorage since 1977 and now has more than 10,000 subscribers. However, shortly after the APUC made its selection, two of the three other applicants, as well as two local telephone utilities, filed appeals in Superior Court protesting the decision and effectively preventing any cable television construction in Anchorage or Eagle River/Chugiak for more than a year.

MultiVisions did launch 35-channel cable service in the fall of 1980 on Ft. Richardson and Elmendorf Air Force Base, pursuant to a separate and independent award from the Department of Defense. Penetration rates on both bases exceed 50%.

In January, 1981, MultiVisions finalized a negotiated out-of-court agreement which ended months of litigation, clearing the way for construction in Anchorage, Eagle River and Chugiak. By 1984, the company plans to complete Alaska's most sophisticated cable system, featuring 54-channel capability, addressability, and two-way capability.

MultiVisions will be the first cable system in the United States to install a Comsat-developed "Torus" earth station, capable of receiving signals from six different satellites simultaneously, to provide viewers with a vast array of information and entertainment. The company plans to spend more than $20 million, and employ more than 200 people, to complete the cable project during the next three years.

* * * * * *

Other companies provide cable service in these additional Alaskan communities: Barrow, Eielson Air Force Base, Port Lyons, Skagway, Hoonah, Haines, Pelican, and Thorne Bay. The Alaska Public Utilities Commission is now evaluating applications to provide cable service in Kenai.

The Alaska Cable Television Association was founded in 1973 to give individual cable companies a means to work cooperatively toward the industry's common goal - the best possible telecommunications service throughout the state of Alaska. For further information on cable TV in Alaska, please contact the author, ACTA president Robert N. Uchitel, at MultiVisions, 4792 Business Park Blvd., Anchorage, AK 99503, (907) 276-0400.

Economics

ECONOMIC FEASIBILITY OF UPGRADING TELEPHONE SERVICE IN ALASKAN VILLAGES

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SRI has developed an analytical structure that determines capital costs, revenue requirements, expected subscriber revenues, and transfer payments between service providers when telecommunications facilities are introduced or enhanced in remote locations. The method can be used to assess the impact on the three jurisdictions (interstate, intrastate, local) of upgrading a particular village, a subset of villages, or the entire bush community. Three candidate upgrades are compared in terms of added costs, stimulated revenues, and net financial burden on both provider and ratepayer.

Results for 158 villages show that revenues, though substantial, would fall far short of covering costs -- which are especially high in bush-Alaska. Because of current agreements prescribing subsidy flows among the service providers (AT&T, Alascom, and the local companies), the impact on Alaskan ratepayers will probably be minimal. However, if transfer payments are eroded by the general trend towards deregulation, the effect on village telephone service could be catastrophic.

1. INTRODUCTION

1.1 THE PROBLEM OF PROVIDING UNIVERSAL SERVICE IN BUSH-ALASKA

For the nation as a whole, universal telephone service has, in effect, been achieved: 98% of all households have a telephone. Among the individual states, such pervasiveness is highest in Hawaii (107%); lowest in Mississippi (86%). The average for Alaska is 89% [1] . Yet in the Alaskan bush--as represented by the 158 remote communities included in this study--only 13% of village households have a telephone.

Prior to 1970, it was uncertain whether villagers desired--or even needed--telephone service. However, during the past decade, most bush communities have been brought rather abruptly into the twentieth century. Forces behind this change include the Native Claims Act, the economic impact of the Alaskan pipeline, and Alaska's newly acquired wealth as a major oil producer. Today, it is apparent that many villagers--perhaps most--desire a personal telephone and the services it offers. This is evidenced by the 22 communities (out of the 158 examined) that now have such service: 65% of the households have become paying subscribers over the past 2 or 3 years.

There are two primary reasons why demand in remote communities has remained unfulfilled. First, universal service is extremely expensive to provide at these locations--so expensive, in fact, that revenues (both toll and local) paid by subscribers fall far short of paying for the services provided. The number of potential subscribers in each village is too small to fully manifest economies of scale: the high fixed cost of local and toll plant must be shared by few users. Further, extreme remoteness, severe weather, scarce labor, and intractable soil conditions all tend to increase costs (both initial and annual) considerably.

In 1979, the annual revenue required by the local companies serving the 22 villages was approximately $980 for each main station (telephone number) [2]. The revenue required by Alascom to furnish "gateway" facilities to connect these villages to the outside world was about $1650 per main station--and this figure excludes the costs of such common (shared) facilities as the satellite transponder and bush channel equipment at the Bartlett central earth station. Thus, total revenue required from each main station to ensure a reasonable (i.e., 9-13%) rate of return on investment exceeded $2600 per year. In contrast, the Bell Operating Companies were able to provide local and intrastate toll service to their multitude of customers in the lower 48 at $560 in revenue requirement per main station in 1978--only 21% of the bush requirement.

It would be surprising if the average village subscriber would or could pay an annual phone bill of $2600 ($217 per month)--and, indeed, he does not. Local revenues for the 22 villages for 1979 averaged about $300 per year per main station: toll revenues, slightly under $700. The total amount

collected per main station ($1000) would easily meet the revenue requirement of a large service provider in the lower 48, but accounts for only 38% of that needed in the bush. The other 62% must come from elsewhere.

The remaining 136 villages have a reduced form of service, termed bush-phone--a single telephone in each village, to be shared by all. These are less expensive to install and operate, but are even more costly on a per-main-station basis, since the entire village toll facility sustains only one or two telephones.

For the entire village set, each of the 1101 main stations in operation produced, on average, a revenue of $2180 during 1979, yet required a revenue of $5995. Thus, whether local exchange service or bush-phone service is provided, most of the revenues must currently be obtained elsewhere in the form of transfer payments from the intrastate (Alaska) or interstate (nationwide) revenue pools.

The second barrier to improved telephone service in the villages is the issue of who would pay for such improvements. Current "Ozark" formulas generally used to allocate the intrastate and interstate transfer payments are not entirely appropriate to such an extreme rural environment and tend to place an extra burden on the Alaska intrastate pool. Moreover, the recent federal trend toward deregulation augurs a decrease in relative interstate contribution. It would appear, then, that any major bush expansion program would lead to a further increase in intrastate rates: the burden would fall primarily on those who make long-distance calls within Alaska. In the face of increasing pressure--and perceived economic disincentives--to provide improved telecommunications services at these locations, Alascom (Alaska's toll carrier) retained SRI to conduct the study on which this paper is based.

1.2 PURPOSE, STRUCTURE AND SCOPE

This study is an exploratory attempt to assess proposed telecommunications service improvements in terms of their expected costs, revenues, economic feasibility, and ultimate rate impact. It departs from most village telecommunications studies in its accounting of payments among service providers as well as from service subscribers. Only a brief summary of the methodology and of key results is presented here; a detailed description is contained in [2].

Numerous studies have been conducted to estimate and model the costs of local exchange service in remote areas [3, 4, 5, 6] and to propose alternative approaches such as subscriber-loop radio [7]. Alternative technologies, such as microwave, and new technologies, such as remotely controlled digital switches, promise to reduce costs if implemented in the future, but have yet to be proven. Since they are not yet being used, they are not considered here. Of the more conventional technologies, we have chosen three. These alternatives would upgrade current facilities at each location to:

A. Reliable Bush Phone--a single phone, shared by all

B. Reliable Toll Access--several phones, for outside toll calls only (1)

C. Reliable Local Exchange--full universal CDO service (2)

(Capacity to serve estimated telephone demand is assumed for the last two alternatives.)

The three options have one enhancement in common: increased reliability. Existing bush facilities, be they VHF radio links or more modern satellite earth stations, suffer frequent outages--often of considerable duration. On average, equipment was "down" 13% during 1979; about 7% of the villages were without service 40% of the time (3). Although this situation could be worse, availability still falls far short of overall national standards. Such unreliable service is irritating, diminishes potential revenues, and can have serious consequences, especially during emergencies.

The study structure is relatively straightforward and can be summarized as follows: First, for each of these three investment alternatives and for each of 158 villages, the capital costs of upgrading existing facilities is determined, using upper-bound and lower-bound cost models. These first costs are then annualized, and the resulting revenue requirement increments are apportioned among the three responsible jurisdictions (interstate, intrastate and local). Main station demand for each village is then estimated, as are the added revenues that might be stimulated by each upgrade. The revenue increments are apportioned among the same three jurisdictions, allowing us to calculate the portion of the total burden (i.e., revenue shortfall) that will fall on each. Finally, results are summed over all the villages to determine overall rate impact (4).

In general, the study is a snapshot taken at the end of the 1980 calendar year and focusing exclusively on the villages. Thus, not all locations in Alaska are included, nor are all bush locations (5). Nevertheless, this village set accounts for most rural places in the state that could benefit from improved telecommunications. Total estimated population today is 28,325, or about 6% of that for Alaska.

All possible message toll service (MTS) revenue sources are included (generated by calls both to and from the villages); private line revenues are not. Questions concerning the adequacy of the overall intrastate revenue pool level are not examined; neither is viability beyond the first year of assumed plant expansion. Finally, the incremental methodology used throughout our analysis, despite its academic orthodoxy, may not necessarily

conform to standard accounting procedures as practiced by telecommunications utilities and the regulatory agencies that oversee them.

2. COSTS

2.1 CAPITAL COSTS

To develop realistic estimates of the cost of expanding telecommunications facilities in remote areas of Alaska, SRI drew from two types of sources: studies and data relating to existing plant now in place; and cost estimates for new plant proposed for future expansion. Historical costs for plant in service are well documented by the Alaska Public Utilities Commission, the Rural Electrification Administration and by Alascom, and have been analyzed by many previous studies [3,4, 6]. These data were used as a baseline against which to measure any incremental additions and as a testbed to verify the modeling approach used.

The bush-phone and the toll-concentrator (as modeled in this study) are relatively simple implementations; their costs can be estimated quite easily. In contrast, the cost of a community dial office (CDO)--in terms of both inside and outside plant--depends on a number of factors including the number of main stations it serves.

Because of high fixed costs, economies of scale are pronounced for both local and toll portions of CDO plant. Within the capacity range for small villages (i.e., 10-120 main stations), the first cost (initial investment) required for toll plant exceeds that for local plant by a considerable margin, although toll plant exhibits higher scale economies. Since the average village CDO serves 46 main stations, these economies of scale are only partially realized: costs are more than a factor of three higher than would obtain at full scale (e.g., at 750 main stations or above). This is one reason why the costs of telephone service in bush-Alaska are so high.

Figure 1 summarizes the model used to assess upper-bound capital costs of installing new CDO facilities. The total cost function is shown in the top figure; cost per main station, at the bottom. Shown on a separate scale is annual revenue requirement at 36.5% of first cost (see the Appendix). The local model is partially based on recent data from United Utilities for six villages but understates United's case slightly. The toll model is based on Alascom data, assuming upper-bound costs for installing a small earth station (SES).

As reflected by this model, unexploited scale economies are even more evident. Assuming, as before, 46 main stations for an average village (6), average cost per main would be more than $19,000--almost four times the average cost of providing a much larger community with 750 main stations or more.

The toll-concentrator, being a smaller switch (capable of fitting inside existing shelters in most cases) would require a relatively small initial investment. However, because its trunking efficiency would be less than that of the CDO (7), variable costs (i.e., marginal costs of additional main stations) would be higher for both inside and outside plant.

The major cause of village communication outages is unreliable electric power--usually in the form of voltage surges, "brownouts," or outright breakdowns. Therefore, the upper-bound cost estimates include provision of a separate $50,000 diesel generator system to be used for telecommunications at each location. However, the telephone company need not own and operate the generator, and the generator need not be solely dedicated to telecommunications. Thus, for purposes of establishing a lower bound on telecommunications costs, the generator can be excluded. In addition, remaining costs are assumed to be 20% less for the lower-bound estimates.

In general, the incremental costs of any proposed investment alternative will depend directly on existing telecommunications facilities in a village: it will cost more to upgrade a VHF bush phone to CDO status than to upgrade a SES bush phone to that same status. Table 1 summarizes the cost models used in this study for each upgrade considered and for both upper-bound and lower-bound assumptions. Both fixed and variable cost components are shown, where applicable. In addition, costs are further broken down by type of plant (toll, local) to facilitate subsequent allocation of these components to the three jurisdictions (interstate, intrastate, local) that ultimately must pay for them.

Although actual costs during implementation could fall outside these bounds, efforts were taken to make them as realistic as possible, considering the bush environment. Thus, they may appear overstated, compared to more academic estimates. However, most academic cost studies concentrate on purchase cost and usually ignore the additional cost of installation altogether. Costs shown are installed costs (including labor)--either actual or proposed; annualized costs include operation and maintenance of the equipment.

2.2 REVENUE REQUIREMENT ALLOCATIONS

Formulas used for allocating costs among the three jurisdictions (interstate, intrastate, local) vary according to the accounting procedures used and the data employed. For bush-Alaska, we assume the following:

- Annual revenue requirement for new facilities is 36.5% of first cost (see the Appendix).
- Toll plant (i.e., SES facilities and any other equipment dedicated solely for toll use) is allocated at 80% interstate, 20% intrastate.

- Local plant (i.e., CDO facilities used jointly for local access, local-switched service and toll-switched service) is allocated at 26% interstate, 54% intrastate and 20% local (8).

3. MAIN STATION DEMAND

We assume the main determinant of main-station demand to be households; the main determinant of households to be population. The recent upsurge in housing construction projects for bush locations is expected to continue, with household growth exceeding population growth by 3% over the next decade, irrespective of village type. At the onset of CDO service, we expect about 64% of the households in a village to desire service immediately (9). This ratio would grow to 84% in 5 years and would begin to saturate in 10 years at 90%. Assuming business main-station demand at 20% of total demand (10), total demand at 125% of residential demand would thus be 80% of village households in 1980, growing to 105% by 1985 and saturating at 112.5% by 1990.

Thus, total demand for main stations is estimated and projected as:

	1980	1985	1990
Residential	3,672	6,121	8,330
Business	918	1,530	2,083
Total	4,590	7,652	10,413

where main-station demand for toll access is assumed to be business demand plus two coin phones for each served location.

4. REVENUES

Given a specified addition to existing telecommunications facilities in a particular village at the beginning of 1980, what increment in annual revenues might accrue? The answer to this question depends on the type of existing plant and the revenue it now produces. It also depends on the type of plant expansion proposed (e.g., investment alternatives A through C) and on the revenue stimulation expected from each.

The basis for the revenue analysis conducted in this study is a detailed data base of village MTS traffic and revenues for the full 1980 calendar year. Similar statistics for 1978 and 1979 were also collected as were time-series data for selected villages and data for most of the local companies serving bush locations.

After several approaches were tested, the final method chosen was to develop revenue stimulation multipliers and to apply them to actual 1980 revenues for each sample village, thus retaining village uniqueness (11). The final multipliers were determined after several iterations to ensure a reasonable and consistent set of results. They can be summarized as follows:

Existing/New Plant

	A (Bush-Phone)	B (Toll-Access)	C (CDO)
VHF Bush-Phone	2.0	3.0	3.5
SES Bush-Phone	1.2	2.0	2.5
CDO			1.2

Thus, upgrading a village currently served by an SES bush-phone to more reliable bush-phone service would increase existing toll revenues by 20%; upgrading it to reliable toll-access service would double revenues; upgrading it to full universal service would multiply toll revenues by a factor of 2.5.

Results were calculated in three steps. First, using the above multipliers, the new level of village-generated revenues was estimated, based on the particular investment alternative proposed. Second, existing revenues were subtracted to yield incremental revenues from the villages. Finally, revenues from toll calls were amplified (12) to include calls billed elsewhere (i.e., sent collect from the villages and sent paid from the outside to the villages). These amplified toll revenues were then added back to remaining revenues (i.e., access fees for the toll-concentrator; local charges for the CDO) to arrive at an overall increment.

The local portion of CDO revenues was estimated from the number of main stations added (developed in the section above), assuming a revenue per main station of $300. The access revenues for the toll-concentrator were also calculated on the basis of the number of main stations added (excluding coin phones), but with an access fee of $100 per month. Based on the analysis of 1980 statistics, 24% of bush-phone revenues were allocated to interstate, 76% to intrastate. For the toll-access and CDO alternatives, this allocation was modified slightly to 21% interstate, 79% intrastate.

5. FEASIBILITY RESULTS

Results obtained thus far are summarized in Table 2 for both the best and worst cases modeled (13). It should be stressed that these totals for the entire set of 158 villages are incremental quantities based on uniform investment strategies. An optimal mix of the three investment alternatives considered could reduce costs considerably.

The overall capital investment required would be substantial, ranging from $32.2 million for a uniform upgrade to reliable bush-phone service (A) to $77.8 million for upgrading all villages to reliable universal service (C). The latter upgrade would add 3602 main stations to the 988 currently in place at an average incremental outlay per main of $21,600. The average number of main stations added per village would be slightly less than 23; the new main station level would be less than 29. Hence, average village scale would be extremely low; average cost per main extremely

high--an upper-bound revenue requirement of almost $9200 if common costs are included. This is over fifteen times the overall national average per main of about $600.

Stimulated revenues are expected to be considerable, especially for the CDO, amounting to over $5.1 million or $1420 per main, but would only cover about 16% of the revenue required. Given current agreements, most of the shortfall burden would fall on the interstate jurisdiction; however, all jurisdictions would feel some impact. The reliable bush-phone (Alternative A) appears to be a poor investment choice, especially in view of the marginal service it offers.

6. RATE IMPACT

Given the results of the previous section, it is possible to estimate the overall rate impact of installing any of the three posited alternatives uniformly in all the villages. We shall use the example that produces the maximum impact (full CDO service with upper-bound costs) to illustrate the methodology; all other cases can be similarly deduced.

The current intrastate pool level is approximately $40 million for Alaska. Installing or upgrading CDOs in all 158 villages would stimulate $3.24 million in additional intrastate revenues, for a new pool level of $43.24 million. The intrastate shortfall is expected to be $6.19 million (worst case). Thus, an increase in intrastate rates of as much as 14.3% (6.19/43.24) may be needed to cover this shortfall.

Using the same argument and the results of Table 2, the following intrastate rate increases can be estimated for all cases considered in this study:

Alternative	Intrastate Rate Impact	
	Worst Case	Best Case
A: Bush-Phone	6.3%	3.7%
B: Toll-Access	4.4%	1.5%
C: CDO	14.3%	9.3%

Although there is no overall local "pool," we can use the same argument to estimate impact on local rates. Since the average local revenue per main station is approximately $300 and since 4590 main stations would be required to meet initial demand, the local "pool" would be approximately $1.38 million. Thus, to cover a worst-case local shortfall of $567,000, local rates would have to increase by 41.8%; to cover a best-case shortfall of $245,000, they would have to rise by 17.8%.

It is also possible to investigate the effect on intrastate and local rates of a major reduction in interstate contribution. In particular, assuming no interstate subsidy at all (i.e., an incremental interstate contribution to bush-Alaska that equals incremental interstate revenues from bush-Alaska), the entire interstate shortfall would fall on either the intrastate pool, on the local companies serving the villages, or on both. If the intrastate pool assumed the burden, the impact could be considerable. For the worst case considered (CDO alternative with a $21.1 million additonal shortfall), rates would increase by 63.1% compared to 14.3% for no such additional burden. For the best case considered (toll-access alternative with a $13.2 million additional shortfall), rates would increase by 30.7% compared to 1.5% without the added burden.

Further, for the CDO, if neither pool subsidized the local companies, the entire shortfall would have to be borne by village subscribers and would produce a catastrophic, impractical increase in local rates. For the most optimistic case considered each subscriber, on average, would have to pay an additional monthly bill of $361 per month for local access compared to an additional $4.45 per month as predicted by the results of this study. For the most pessimistic case, each subscriber, on average, would pay an additional $506 per month (compared to $10.47). Since the average village subscriber now pays approximately $25 per month for local access (including installation fees and any miscellaneous charges), the importance of retaining these transfer payment subsidies is clearly demonstrated.

7. CONCLUSIONS

Major conclusions can be summarized as follows:

- In aggregate, revenues fall short of covering the revenue requirements--irrespective of the investment alternative chosen. On average, revenues (including outside call stimulation) cover less than 25% of those needed to break even. Village-generated revenues would cover still less.

- Nevertheless, given current settlements agreements, overall impact on the Alaskan intrastate pool is expected to be moderate. Even under worst-case assumptions, the rate increase needed to implement the enhancements posed is not expected to exceed 15%. Local rates may have to rise substantially, however (e.g., 18%-42%).

- The impact on the current interstate pool may be considerable--as much as $21 million in additional contributions could be imposed. However, considering the current interstate contribution level for Alaska as a whole, the relative impact may be moderate.

- Installing (or, for some villages, upgrading) CDOs in all the villages (Alternative C) appears, at best, to recover 45% of intrastate revenue required. The bush-phone alternative is the least viable of the three examined.

- A uniform investment policy (i.e., installing the same facilities in every village) is suboptimal. Any pessimistic conclusions drawn above can be ameliorated to a considerable extent by selecting the alternative that performs best for each village.

Thus, it appears that a major program to upgrade bush telecommunications could be accomplished with minimal impact on intrastate rates. However, this conclusion is preliminary. It depends to a large extent on the health (i.e., current rate of return) of intrastate services in general. It is also based on the assumption that interstate contributions will continue, unabated.

FOOTNOTES

(1) Toll-access is a transitional form of telephone service, providing toll service (but not local service) to a limited number of subscribers by means of small switch, such as a PABX, acting as a line concentrator.

(2) Community Dial Office (CDO)--a small local exchange, providing switched telephone service (toll and local) to residence and business locations.

(3) Availability data on 103 villages during 1979. Even satellite-served CDO locations are not immune: a recent Alascom study of 17 sample villages showed an average availability of 93% and a mean time between failures of 20 days during the first 4 months of 1980.

(4) To keep the initial study [2] within bounds, the 158 villages were typified by a carefully selected sample of 40; totals were then extrapolated. These same extrapolations are presented here: a subsequent automated analysis of the entire village set produced almost identical results.

(5) The larger villages (e.g., Bethel, Barrow, Kotzebue), most nonnative communities (e.g., Anchorage, Fairbanks, Juneau) are omitted either because they are not "bush" or because communications facilities are generally considered adequate--at least relative to those under study.

(6) Average village demand is estimated to be 29 main stations today, growing to 48 in 1985, and saturating at 66 by 1990.

(7) Assuming Poisson traffic statistics and a blocking probability of .02, seven CDO main stations per trunk can be accommodated, on average; only three main stations per trunk for the average toll-concentrator.

(8) Based on a recent internal Alascom study of three local companies and on analysis of conversation-minutes.

(9) Twenty-two villages now have local exchange service, and 65% of the households subscribe. Since most of these villages have had service for an average of only a year or two, it is reasonable to use a similar figure for our initial demand estimate.

(10) Of the 988 CDO main stations serving 22 villages in December 1978, 187 were business and 31 were coin.

(11) It could be argued, in fact, that toll revenues are a better indicator of village economic activity than census data on per capita income--even when these revenues may be suppressed by inadequate facilities.

(12) Village-generated toll revenues were multiplied by 2.650 for the bush-phone; 1.973 for the toll-concentrator and the CDO.

(13) These feasibility results include the shared annual costs of such common facilities as the space segment, channel equipment at the Bartlett earth station, and microwave trunks between Talkeetna and Anchorage. However, common costs unallocatable to the villages (such as general overhead) are not included.

APPENDIX: REVENUE REQUIREMENTS

Within the telecommunications industry, various cost accounting approaches abound. Methodologies include Long Run Incremental Cost (LRIC), Fully Distributed Cost (FDC), Historical Cost, Present Worth of Annual Costs (PWAC), Cash Flow Accounting (CFA), and Depreciation Accounting (DA). Moreover, the set of formulas used to determine transfer payments among the various carriers differs from all of those just mentioned and is subject to periodic revision.

However, revenue requirements are usually developed according to the particular DA model described by the FCC as follows [8].

"R = E + (P-D)K

R is the annual revenue requirement.
E is the annual operating expense.
P is the property or plant used in producing the services.
D is the accumulated depreciation reserve.
(P-D) is the rate base for a carrier, i.e., the original cost of property less depreciation.
K is the rate of return which is derived from the costs to a carrier in securing capital."

Further, the FCC includes current depreciation expense as part of annual operating expense, E, and uses straight line, average service life, group depreciation.

We will use this form as the basic revenue requirement model, but expand it somewhat to explore each cost element separately. Changing notation:

RR = RRF x FC + OM

where

RR = revenue requirement
RRF = revenue requirement factor
FC = first cost (initial investment, undepreciated)
OM = annual operations and maintenance costs.

Some additional notation is needed:

N = plant lifetime (years)
n = number of years plant has been in place
X = n/N = portion of plant life expended
I_o = first cost (initial investment)
I_n = net plant (depreciated initial investment, or book value)
r = rate of return
i = interest rate
t = tax rate
C = composite capitalization factor

Note that, for straight-line depreciation, $I_n = (1-X)I_o$.

The revenue requirement factor is comprised of three terms; each can be developed as a function of first cost:

Return: The regulated rate of return on net plant (on the rate base). Thus

$$\text{Return} = rI_n = r(1-X)I_o$$

Taxes: The amount of federal and state taxes paid on taxable income. Taxable income is return (above) minus the fixed cost of capital; cost of capital is the interest rate multiplied by the portion of net plant capitalized. Thus

$$\begin{aligned}\text{Taxes} &= t(\text{return}-iCI_n)\\ &= t(r-iC)I_n\\ &= t(r-iC)(1-X)I_o\end{aligned}$$

Depreciation: The dollar amount of plant depreciated every year until exhaust. For straight-line depreciation, this is linear:

$$\text{Depreciation} = I_o/N$$

Combining terms, the revenue requirement factor becomes:

$$\text{RRF} = [r+t(r-iC)](1-X) + 1/N,$$

where the first term is a combination of return and taxes and the second term is depreciation. Surprisingly, in contrast to cost annualization based on the capital recovery factor, revenue requirement decreases as the interest rate increases. This seeming paradox is the result of reduced taxes borne by the service provider who then passes this reduction on to the consumer. Of course, over the long-term, the rate of return would eventually be adjusted upward to reflect any large increase in the cost of capital.

For Alascom, the following apply:

r = 13%
i = 8.75%
C = 34%
t = 104.4% (19.2% state and 85.2% federal)
N = 15 (composite)

Hence,

$$\text{RRF} = 0.23466\ (1-X) + 0.06667$$

For this study, the formula must be applied for two different cases: bush investments that have been in place for about 3.5 years, and new bush investments after one year of operation. The two results are RRF(n = 3.5) = 0.2466 and RRF(n = 1) = 0.2857.

Thus, since OM is 8%, the Revenue Requirement is

32.7% of First Cost for old plant.
36.5% of First Cost for new plant.

These formulas are used to estimate the economic viability of historical and new bush investments, as appropriate, throughout this analysis. Although they could be further developed to arrive at an annualized present worth of all 15 cash flows occurring until plant exhaust, they suffice for our purposes here.

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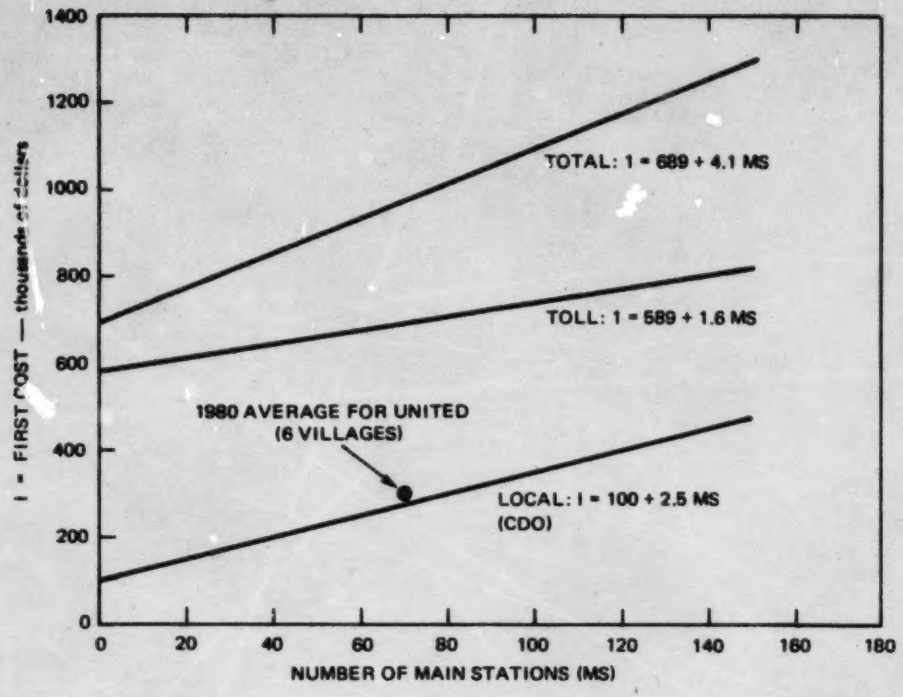

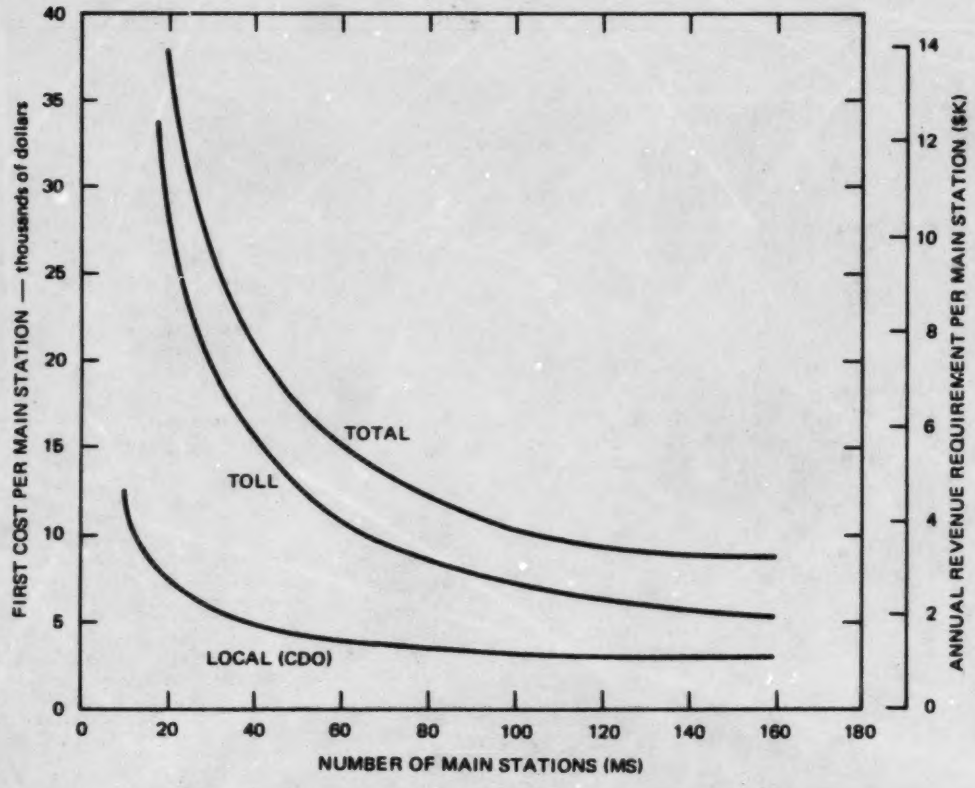

FIGURE 1 NEW INVESTMENT AS A FUNCTION OF SUBSCRIBERS SERVED

TABLE 1: COST MODELS OF UPGRADES

Invest. Alt.	Upgrade	Plant Type	First Cost	
			Upper Bound	Lower Bound
A	1A	Toll:	$600K	$440K
	3A	Toll:	168K	94K
B	1B	Toll:	$589K + 3670 MS	$431K + 2940 MS
		Access:	29K + 2960 MS	23K + 2370 MS
		Total:	618K + 6630 MS	454K + 5310 MS
	3B	Toll:	157K + 3670 MS	86K + 2940 MS
		Access:	29K + 2960 MS	23K + 2370 MS
		Total:	186K + 6630 MS	109K + 5310 MS
C	1C	Toll:	$589K + 1570 MS	$431K + 1260 MS
		Local:	100K + 2500 MS	80K + 2000 MS
		Total:	689K + 4070 MS	511K + 3260 MS
	2C	Toll:	589K + 1570 MS	431K + 1260 MS
		Local:	2500 MS	2000 MS
		Total:	589K + 4070 MS	431K + 3260 MS
	3C	Toll:	157K + 1570 MS	86K + 1260 MS
		Local:	100K + 2500 MS	80K + 2000 MS
		Total:	257K + 4070 MS	166K + 3260 MS
	4C	Toll:	157K + 1570 MS	86K + 1260 MS
		Local:	2500 MS	2000 MS
		Total:	157K + 4070 MS	86K + 3260 MS

Notes: - MS = main stations ; K = thousand

- Plant type refers to physical location and function, not to the cost categories used to calculate toll settlements.

- Incremental upgrades are defined as follows:

1) Upgrade from non-SES bush-phone to: 1A = reliable SES bush-phone
1B = reliable SES toll-concentrator
1C = reliable SES CDO

2) Upgrade from non-SES CDO to: 2C = reliable SES CDO

3) Upgrade from SES bush-phone to: 3A = reliable SES bush-phone
3B = reliable SES toll-concentrator
3C = reliable SES CDO

4) Upgrade from SES CDO to: 4C = reliable SES CDO

Table 2: SUMMARY OF FEASIBILITY RESULTS
(Totals for 158 Villages)

	INVESTMENT ALTERNATIVES		
	A (Bush-Phone)	B (Toll-Access)	C (CDO)
WORST CASE:			
First Cost ($K)	$ 47,208	$ 56,231	$ 77,790
Revenue Req. ($K)	17,738	23,511	33,054
Intrastate	3,548	4,702	9,428
Interstate	14,190	18,809	21,968
Local			1,658
Revenues ($K)	1,242	3,591	5,176
Intrastate	944	2,837	3,235
Interstate	298	754	860
Local			1,081
Rev./ Rev.Req. (%)	7.0%	15.3%	15.7%
Shortfalls ($K)	16,496	19,920	27,878
Intrastate	2,604	1,865	6,193
Interstate	13,892	18,055	21,108
Local			577
BEST CASE:			
First Cost ($K)	32,254	39,505	55,956
Revenue Req. ($K)	12,280	17,406	25,084
Intrastate	2,456	3,481	7,271
Interstate	9,824	13,925	16,487
Local			1,326
Revenues ($K)	1,242	3,591	5,176
Intrastate	944	2,837	3,235
Interstate	298	754	860
Local			1,081
Rev./Rev. Req. (%)	10.1%	20.6%	20.6%
Shortfalls ($K)	11,038	13,815	19,908
Intrastate	1,512	644	4,036
Interstate	9,526	13,171	15,627
Local			245

NOTE: First cost is for village facilities only; all other quantities include common costs.

The History of Telecommunication Subsidies in Northwest Canada and Alaska: A Comparative Analysis

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1. Abstract

The history of the role of subsidies in the telecommunications development process is explored in this paper. The evidence indicates that subsidies have not been effective in promoting telecommunication development in rural and remote regions of Northwest Canada and Alaska. This is attributed to a failure to implement subsidy methods that overcome institutionalized structural incentives of the telecommunication industry and government agencies.

2. INTRODUCTION

Subsidy policies are usually examined in light of their viability as methods of implementing social policy objectives. The availability of telecommunication services in isolated northern regions such as Northwest Canada and Alaska has been assumed to be largely a function of the successful use of subsidies. In this paper the history of subsidy policies or practices that have been used to promote northern telecommunications development is reviewed. The analysis indicates that while it is correct to argue that subsidies have played a crucial role in telecommunications development, only rarely have they been effective in implementing social policy objectives. Social objectives, i.e., provision of adequate basic service in remote and rural areas, historically have been a peripheral consideration.

Subsidies, initiated by government agencies and/or by the telecommunication industry, have had a profound effect on the telecommunication development process. However, insufficient attention has been given to questions as to why subsidies often have been ineffective in promoting development in rural and remote areas. Most studies fail to contribute to an understanding of this issue because of the narrow focus of analysis.

Analyses of subsidies usually are restricted to specific programmes that transfer financial resources to meet narrowly defined policy objectives. Subsidy programmes are then examined in isolation from the institutional context in which they originated. Questions concerning subsidies, their magnitude and political and economic viability, are not raised because the institutional context is ignored or assumed to be supportive.

Decisions to provide subsidies depend on a large number of political and economic factors. Thus, and appropriate method of analysis requires examination of institutional and structural factors. It also requires that the subsidy problem be defined to include the methods to be used by government and/or the telecommunications industry for implementing the subsidy policy. Subsidies must include methods of allocating financial resources to develop services that would not have been provided under private market conditions, i.e., where the direct users are able to pay the full costs.

3. THE TELECOMMUNICATIONS DEVELOPMENT "PROBLEM"

The economic problems encountered in the telecommunication development process in remote and rural areas are similar in Northwest Canada and Alaska. Isolation, population size and demography, geography, and high costs have been named as factors preventing development of adequate basic services. In areas where demand for service is not found to generate sufficient revenues, in aggregate, to cover assigned costs, decisions have been made to postpone service development. When telecommunications services in Northwest Canada and Alaska have been compared with national standards and stated telecommunications objectives, they have been found inadequate(1). Policy statements in Canada and the U.S. indicate a desire to assure equality in the availability of basic services, and government obligations to ensure that policies are implemented(2). Unfortunately, national policy objectives cannot be equated with very different objectives that have been given priority in the policy implementation process.

The history of telecommunication development in Northwest Canada and Alaska provides clear examples of the low priority given to service development in remote and rural areas. Despite many alternative ways of financing telecommunication development, conflicting incentives and dominant economic interests have prevented policy objectives from being implemented. Subsidies have been used to promote telecommunications services to meet demands by the military, resource industries and government agencies. Only occasionally have they been used to meet requirements of residents of isolated northern communities. Thus, emphasis has not been on implementing telecommunication development policy. The development of telecommunication services has been treated as a component of policies promoting military, industrial, and on occasion government economic and political policies.

4. EARLY TELECOMMUNICATIONS SUBSIDIES

The earliest examples of subsidies promoting telecommunications development in Northwest Canada and Alaska can be traced to the 1850s. Government incentives to private telegraph companies reflected long-term national economic policy objectives. Financial losses were acceptable because of the need for a telegraph link between major trade centres of western Europe and the eastern coast of the U.S.

After the American Telegraph Company failed to construct a trans-Atlantic undersea cable in 1856, the U.S. government favoured an inter-continental link between the Pacific coast and Europe. A route through Northwest Canada, Alaska and Russia was proposed and approved in 1860(3). The "Russian Extension" was to be constructed by the Collins Overland Telegraph Company, a subsidiary of Western Union. Construction of the line was short-lived as the project was terminated in 1866. Political and economic priorities changed, and subsidies for northern telecommunications development evaporated.

Subsidies to private investors took the form of charters and franchises in the tradition described as the "promotional era" in the U.S.(4). Rewards of land and money were granted. The charter legislation for the Collins Overland contained exclusive rights that would have conferred financial benefits on the parent company.

It was not until the 1900s that Alaska and Northwest Canada achieved sufficient economic and political significance to justify further subsidies. During this period subsidies were linked to U.S. military defense objectives. Cost factors associated with telecommunications facilities in Alaska were insignificant by comparison with overall military budgets. In Northwest Canada, the strategic importance of the region for the security of the U.S. national communication defense system justified government subsidies. The development of social or even commercial telecommunication services was incidental to the priority given to military requirements.

The U.S. government Act of 1900 initiated development of long distance telecommunication facilities (5). The Alaska Communication System (ACS) was expanded in response to military demands and its operation was left to the Department of Defense. Costs of operation were included in defense budgets and system development was carried out in isolation from federal policy concerning telecommunications objectives in the Lower 48 States. As the capital costs of the system were obscured within Department of Defense budgets, commercial use piggybacked on the system built for military use could be said to have been subsidized.

In Northwest Canada, the Royal Signal Corps constructed the Northwest Territories and Yukon Radio Systems in 1922(6). The system served military bases and was not connected to southern telecommunications systems. Here again, the Canadian government subsidized the costs of the system which was accessed by mining companies, government offices, etc. In 1943, the U.S. army constructed the Northwest Telecommunications System which interconnected with the ACS and the national network in Edmonton (7). This system was designed for military use and continued in this capacity after 1945 when it was purchased by the Canadian government.

The pervasiveness of subsidies used to meet economic and political objectives of national importance is apparent. The Department of Defense retained control of the ACS until 1969. Canadian National Telecommunications (CNT), a crown corporation, was given responsibility for operation of the joint military/commercial network in Northwest Canada in 1958. No evidence of efforts to create incentives for telecommunication development in remote or rural areas except as an incidental byproduct of military/industrial development, can be found until the late 1960s.

In Northwest Canada, settlement patterns and the location of resources close to the major transportation and communication routes enabled provision of basic telecommunications services to some northern communities. In Alaska, geographic dispersion of the population delayed even minimal service to many communities. Neither the U.S. nor Canadian government designed effective subsidies that would treat national telecommunications policy implementation as a primary objective.

5. SUBSIDIES: 1950s TO PRESENT

The telecommunication system in Northwest Canada expanded tremendously from 1958 onward. Several examples show the priority of industrial and political objectives, and the disregard for fulfillment of basic communication service objectives throughout the region.

The choice of CNT, a public corporation, to provide telecommunications service in Northwest Canada reflected prevailing national economic development priorities. A communication infrastructure was needed to accelerate resource development in the north. Subsidies were designed to "increase the rate of northern development by using publically sponsored investments in infrastructure capital to lead private resource exploiting operations."(8). The costs of subsidies were balanced against the benefits in the "national interest".

CNT received parliamentary appropriations to maintain and operate the telecommunications system. Federal support was also provided through contracts for construction of microwave facilities and major improvements on heavily used communication routes. The government's policy priorities were clearly to establish links between the northwest and the economic centres of the south and the U.S. No effort was made to implement subsidies to support a regional communication system accessible to remote and rural areas. The Canadian government was responsive to demand for telecommunications services from business, industry and government agencies. By the mid 1960s, the region had "...the same communication services as the rest of the country."(9)

However, many communities had no exchange service, continued to rely on HF radio, and were not viewed as sufficiently financially viable to be included in telecommunication development plans.

In Alaska, the ACS experienced little growth in geographic coverage despite increasing demand until its sale in 1969. Discussions relating to the sale of the military system explicitly considered the need to develop adequate statewide telecommunications services. The ACS was sold in 1969 and RCA Alascom was created to provide long distance intrastate services. In contrast to the Canadian government's approach, the U.S. government chose a private investor-owned carrier, the process of utility regulation and legislative controls as the primary means of implementing telecommunications policy objectives. The government's initial concern with subsidies was limited to ensuring that commercial long distance service be provided "at least to the same extent the Department of the Airforce provides such service today."(10) Practical methods of ensuring that incentives would be created to carry out a long-term telecommunication development plan for remote and rural areas were not addressed. Alascom was simply given a contractual obligation "to provide new and improved service to 142 remote communities within three years...."(11)

Policy statements and legal documents showed a concern with a multi-faceted telecommunications development process which would serve government, industry, and residents throughout the State. But, despite these efforts, the growth of the Alaska statewide telecommunication network resulted in a continuing major disparity between service in Alaska and the Lower 48 States, and within Alaska between urban and rural areas.

6. TELECOMMUNICATIONS CORPORATE STRUCTURE

Economic incentives created by the corporate structure of the dominant telecommunications carriers in Northwest Canada and Alaska were not conducive to rural development. CNT (Northwest Telecommunications, Inc., 1979) obtained a monopoly on service development. Its policies have reflected the same principles as its parent company, the Canadian National Railways System, i.e., that it perform as a "commercial entity"(12). Services which are expected to become a financial burden are not pursued unless direct subsidies are made available from government sources(13).

Alascom, as a subsidiary of southern based corporate interests, Pacific Power and Light (RCA until 1979) is also under pressure to maintain an adequate if not increasing profit margin. As the dominant carrier, Alascom has hindered development of local exchange services by local companies through a variety of measures. It has also been generally unresponsive to State rural telecommunication development objectives(14).

The primary incentives directing the behaviour of both carriers are in conflict with the stated objectives of national telecommunications policy.

7. SUBSIDIES FOR REMOTE AND RURAL TELECOMMUNICATIONS

The telecommunications industry in the U.S. and Canada is replete with subsidies between and within classes of service, carriers and geographic locations. These internal subsidies have not been expanded to promote telecommunications development in remote and rural areas to any significant degree. Because internal subsidies have been ineffective in the past as a method of implementing national telecommunications policies, both governments have relied on sporadic direct subsidies(15). However, on the basis of past experience it is unlikely that these methods can be expected to provide long-term solutions to rural telecommunication development problems in either Northwest Canada or Alaska.

Over the past decade northern development policies in Canada and the U.S. have expressed increasing concern for the "quality" of political, social, cultural and economic life of northern people. Nevertheless, disparities in telecommunication services continue as the carriers adhere to methods and criteria for investment appropriate to southern conditions and profitable markets. Government agencies have not devised effective methods for implementing telecommunications policies.

In Canada, the Department of Communications (DOC) began to specifically address northern subsidy questions in the early 1970s. The DOC described its objectives as: "The aim of the department is to have communications frontiers extended northward so that the quality of service may be equivalent to that enjoyed in Southern Canada....Programs involving public and private investment will be encouraged and arranged."(16) Evidence accumulated over the past ten years does not point to a more effective policy implementation process. The real priorities of government subsidies remain confined to communication development for industrial and business interests.

One thrust of the DOC's activities has been to support subsidies for research and development of satellites, trail radio, and other technologies ostensibly for northern use(17). These efforts have been linked more to the pursuit of lucrative contracts for manufacturers than to northern needs for basic telecommunications service.

A second direction has been to provide subsidies for services in small isolated communities. The Northern Communications Assistance Programme was introduced in 1977(18). The federal government committeed financing for the capital costs of facilities connecting isolated northern communities. CNT (and Bell Canada) agreed to invest equal amounts in capital and operating funds for local exchange service. The DOC admitted that this programme was the first step taken by the government to implement its communication policy in the north(19).

Satellite earth stations were installed in several communities before the programme was "delayed" under 1978 government financial restraint programmes(20). The fact that this programme was so

easily abandoned points again to the ineffectiveness of direct subsidies to implement policy objectives. Where they have been unrelated to industrial development in the north, subsidy programmes have been sporadic and tenuous. They have served as temporary solutions applied to a problem that exists because of institutional structural factors.

In Alaska, State and federal agencies have supported the principle of statewide and nationwide telecommunication development, i.e., "universal service". Deficiencies of intra-industry subsidies have been responded to with subsidies from the public sector. As in the Canadian context, these alternatives cannot be regarded as long-term solutions.

The Rural Electrification Administration (REA) has been active in Alaska since the 1950s. A review of borrower companies and locations, indicates that until 1975, the REA assisted with telecommunication expansion in areas that were expected to experience rapid economic growth. After 1975, REA low cost capital loans were used to expand regional service and to take advantage of earth station facilities in unserved communities(21). Despite investments in Alaskan local telephone companies, the REA is a southern based government agency. Its loan criteria emphasize economic stability. Many remote and rural areas cannot meet criteria for loans. The agency is also subject to pressures to invest in innovative interactive telecommunications services by Lower 48 borrowers. The REA can be expected to help to ameliorate telecommunication development problems, but it will not solve them.

Another source of subsidy in Alaska has come from the State Legislature. A resolution was passed appropriating funds for 100 small earth stations to provide long distance service to rural communities in 1975(22). State action was a response to Alascom's intransigence in developing a viable low cost plan for rural telecommunications. This was the first venture by the State government in subsidizing non-experimental communication programmes. But the programme was not considered to be a subsidy. It was seen as a "means of providing the state with permanent proprietary participation in telecommunication planning and policy."(23) The State's earth station programme was not an admission of the need for continuing subsidies to support development of rural telecommunications in the long or short-run. This initial action should be seen as a stimulative injection, not an ongoing practice, much in the same way as support for experimental telecommunications facilities, e.g., satellites, and software, e.g., broadcast educational programming.

8. CONCLUSION

The history of subsidy policies and their effectiveness has been linked to changes in the political and economic significance of northern regions to the Canadian and U.S. governments. The Canadian government has willingly subsidized the costs of a northern telecommunication system to provide incentives for exploitation of natural resources. Direct subsidies have promoted service development in industrial centres. Subsidies for regional telecommunication development have been inadequate.

In Alaska, direct subsidies have been used intermittently in response to instances where telecommunication services has been extremely inadequate or non-existent. They have not been integrated into the telecommunication industry's planning process. These methods have not successfully eliminated disparities in services between rural and urban areas. The idea that national telecommunication policies can be implemented using essentially the same methods which led to development in the Lower 48 States, despite extreme differences in conditions, has been implicit in the history of Alaskan telecommunications development. The greater the deviance of remote and rural communities from average conditions of supplying basic telecommunications service in the more populated areas in Canada and the U.S., the less effective traditional subsidy methods have been.

If national telecommunications policy objectives are to be more than rhetoric and disparities in the quality and availability of service are to be reduced significantly, methods appropriate to the special conditions in Alaska and Northwest Canada must be devised. New methods must be designed in light of knowledge of institutionalized incentives that exist within the telecommunication industry and government agencies. They must be directed to the long-term development of basic services that do not discriminate among geographic locations, but instead seek to fully implement policy objectives.

Policy statements do not distinguish between the requirements of industry, business, and government in central populated areas and residents of remote and rural communities. There is no reason for the impact of subsidy methods to result in a continuing disregard for the need to promote service development to the residents of remote areas. Methods must be designed to overcome the historical tendency for social policy implementation to be constrained by more dominant economic and political priorities of both government agencies and the telecommunication industry.

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Telecommunications Networks: Internal Subsidies and System Extension in Alaska

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1. Abstract

Internal subsidies that have characterized telecommunications development in the Lower 48 States are examined as to whether they can provide the impetus for telecommunication system extension to outlying Alaskan communities. Problems confronting Alaska in its attempts to negotiate satisfactory cost separation and revenue settlement arrangements are examined. The implementation of "universal service" objectives in Alaska requires that larger portions of local exchange common costs be shifted to the nationwide interstate cost pool. Alaska must play an active advocacy role to ensure that viable alternatives are available to regulatory agencies to meet telecommunication development requirements

2. TELECOMMUNICATION AND ALASKAN DEVELOPMENT

The development of Alaska has been, and will continue to be, closely associated with telecommunication. Given the size, climatic conditions, population distribution and terrain of Alaska, the ability of its people to function effectively politically, economically and socially depends upon telecommunication. Native groups of common culture and language require telecommunication services to share their common values, concerns, and aspirations. As an isolated state many thousands of miles from the contiguous Lower 48 States, Alaska's participation in the political, economic, and social affairs of the United States is uniquely dependent on telecommunication facilities and services.

Historically there is little question that Alaskan development has been restricted by the lack of a telecommunication system that could provide a foundation and catalyst for industrial growth and service to Alaskan residents. Rather than stimulate development within the state, telecommunication has lagged behind development in other sectors. Telecommunication systems were introduced and expanded only to meet the imperatives of development in other sectors (e.g., military, resource extraction, etc.) that were going ahead despite the absence of an efficient telecommunications system(1).

Over the past decade, there has been a major expansion in telecommunication investment, usage, revenues, and profits. System capacity and quality of service have been improved over the major telecommunication routes within Alaska and between Alaska and the Lower 48 States. However, extension of the system to include the many small rural and bush communities in outlying areas has not yet taken place, and there is considerable uncertainty as to whether it will.

It is generally accepted that an extension of the telecommunication system to outlying communities requires subsidies because these communities will not be able to generate sufficient revenue to cover the costs of system extension. Indeed, about 75% of the telephones in Alaska are supplied by municipally-owned telcos and most of the private companies were established as local "Mom and Pop" companies, each initially established because private telephone industry capital could not be attracted. Even during the expansionary period of the 1970s, the only significant geographical extension of the system -- other than to serve industrial development relating to the Alaska pipeline -- was done at the initiative of, and with the financial support of, the state. Alascom, the long distance carrier, in fact resisted expansion of the system.

In the mid 1970s, the state legislature appropriated funds for 100 small earth stations to provide at least a single long distance telecommunication connection to some outlying communities after it became apparent that Alascom was not going to extend the system. At present, there are still many bush villages without any connection to the Alaska telecommunications system, and about 175 communities without local exchange service. None of these communities have local service. If local service is to be established and long distance capacity enhanced beyond that of an emergency lifeline for residents of outlying communities, it is apparent that subsidies will be required. But from where?

Mansell has shown that historically telecommunication subsidies in Alaska and in Northwest Canada have been implemented to serve military and industrial resource exploitation objectives, but not to provide service to residents(2). For the short-term future, REA will help only communities that are already at the margin of financial viability, and the state is in the process of withdrawing from its own small earth station program.

This leaves the possibility of subsidies that are internal to the telecommunication system, i.e., subsidies of high-cost geographical areas and services by low-cost geographical areas and services. Internal subsidies have characterized telecommunication development in the Lower 48 States for nearly a century. At present subsidies are still incorporated in telephone industry rate structures, as well as cost separation and revenue sharing practices. Is there any reason why they cannot

provide the impetus for an extension of the Alaskan telecommunication system to its outlying communities?

3. THE CHARACTERISTICS OF TELECOMMUNICATION NETWORKS

As an infrastructure industry upon which all other industries depend, the telecommunications system provides benefits to society that go much beyond the telecommunications industry. Effective communication and timely information leads to improved decision-making throughout the economy. The cumulative economic benefits that accrue throughout society are many times the immediate benefits to the purchasers of telecommunication services(3). In economic terms, these include substantial externality benefits associated with the supply of service, benefits to parties who are not directly involved in the transaction. Thus, criteria for economic efficiency which are defined only in terms of benefits and costs to the parties directly involved in market transactions are poor criteria for measuring economic efficiency in terms of a local, regional or national economy.

In addition, telecommunication systems are characterized by consumption externalities. The subscription of individual users to services directly affects the demand of other users for that service. The value of any telecommunication service to individual users depends on who can be contacted, i.e., the size and structure of network(s) to which the consumer subscribes.

In some important respects, the telecommunication system takes on the characteristics of a public good(4). Its costs and benefits are determined by the characteristics of the total system rather than discrete, independent components. Subscribers share the costs and benefits of the "public good" that they use in common. All parts of the system must be designed to meet criteria for the total system. For example, local exchanges are designed to meet the requirements of long distance service, not merely local service. Telecommunication carriers share in the supply of facilities and services that make up the total system. Users share in the use of the total system. Interdependence of supply and of demand is extremely high. The incidence of joint and common costs is high. Private carrier costs of a portion of interdependent components of the system are not good estimates of the stand-alone costs of separate and independent services. Nor are they good estimates of the costs to society. Prices charged and revenues received by telecommunication carriers are not good estimates of social benefits. A major task for carriers and for regulators is determining the rules for sharing the costs and the revenues of the nationwide telecommunication system, i.e., cost separations and revenue settlements. Major portions of costs and revenues assigned to individual telcos and to jurisdictional services are determined not by market exchanges, but by the results of cost and revenue sharing negotiations. Thus, the portion of the total telecommunication system costs and revenues assigned by Alaska, and to the individual telcos operating in Alaska, depends overwhelmingly on the ability of the various entities to negotiate satisfactory cost separation and revenue settlement arrangements.

4. SEPARATIONS AND SETTLEMENTS IN ALASKA

Historically, costs have not played an important role in revenue settlements in Alaska. The amount per message was negotiated and varied from company to company and from time to time. Available cost and profit information undoubtedly influenced the negotiations but not in any formal sense of cost calculation. As time passed, costs played a more formal role in settlement negotiations for the larger Alaska local companies because cost information represented a valuable tool for negotiation. As Alaska telecommunication has evolved, the local telephone utilities have become more aware that there is a basis for improving revenue settlements. The history of Alaskan toll settlements reflects their attempts to negotiate settlement improvements.

The evolution of Alaska settlements runs parallel to that of settlement agreements in the Lower 48 States, with the exception that developments in Alaska have taken place much later in time. Revenue settlements began in Alaska when the Alaska Telecommunication System (ACS) began making token settlement payments to the local companies for their part in supplying toll services. When the local companies became aware of the fact that settlements in the Lower 48 States were made on a more favourable basis, they began negotiations with ACS. The Alaska Telephone Association was created to deal with the problem of toll settlements.

The initial negotiations resulted in an agreement that provided for an average per message settlement on a "cents per message" (CPM) basis, similar to that negotiated between ATT and the U.S. Independent Telephone Association (USITA) in the Lower 48 States. The settlement included an Alaska factor of 45%. In 1955, the Alaska factor additive was negotiated at 55%(5).

Changes in the ATT/USITA basic settlement agreement required an adjustment of the additive factor after 1955. In 1958, settlements were increased about 10%, but on the new Lower 48 schedule the Alaska additive factor was 30%. Anchorage and Ketchican found the settlement unacceptable and began investigating the possibility of cost studies. Anchorage began to conduct cost studies. Ketchican began such an effort and later abandoned it.

During the 1960s a diversity of settlement arrangements came about as some local companies such as Anchorage and a few other companies began to undertake cost analyses and use them in negotiations with ACS, while other carriers negotiated on other grounds. Thus, when AEA Alascom took over the ACS, there was no consistent basis of revenue settlements. In 1970, settlements per message varied among local companies from $0.66 to $1.31, a range of almost 100%.

Throughout the 1970s, Alascom instituted many changes in settlement arrangements with the local telcos, with substantial differences among companies. Table I provides summary settlement information for 1976. It is apparent that there is no consistent pattern to settlements either on the basis of per message payment or the percentage retention by Alascom. By 1976, 42% of toll revenues were being paid to local companies through settlements(6).

TABLE I. TOLL SETTLEMENT DATA: ALASCOM/LOCAL COMPANIES, 1976

Intrastate

Local Company	Settlement per Message	Retention by Alascom
Anchorage	$ 0.78	47%
Fairbanks	1.13	35
Glacier State	1.45	(44)
Juneau/Douglas	1.47	32
Matanuska	0.43	31
General	0.49	69
Ketchikan	1.06	32
Sitka/Southeastern	0.52	54
Copper Valley	0.67	31
Interior	1.56	(4)
National	0.61	41
Cordova	0.63	48
OTZ	0.68	67
Nushaqak	0.70	65
GAB	0.50	(26)
Bristol Bay	0.79	52
Yukon	0.72	38
Whittier	0.37	47
Bush-Tell	0.56	59
Mukluk et al.	0.89	6
Bettles	0.57	59
TOTAL	$ 0.87	36%

Interstate

Local Company	Settlement per Message	Retention by Alascom
Anchorage	$ 1.89	76%
Fairbanks	2.60	67
Glacier State	4.34	44
Juneau/Douglas	2.90	53
Matanuska	4.20	47
General	3.37	51
Ketchikan	1.71	70
Sitka/Southeastern	2.76	55
Copper Valley	5.52	28
Interior	10.80	(31)
National	3.60	43
Cordova	3.98	40
OTZ	3.84	54
Nushaqak	3.66	51
GAB	4.55	44
Bristol Bay	4.77	37
Yukon	5.35	30
Whittier	9.18	(12)
Bush-Tell	8.18	(10)
Mukluk et al.	8.56	(29)
Bettles	7.49	16
TOTAL	$ 2.58	66%

However, this tends to overstate the real payment to local companies. Alascom has been extremely aggressive in siphoning off toll revenues to special Alascom private line services, which are not part of the toll settlement process. The local companies are in no position to compete with Alascom for these services because Alascom sets the rates for the competing toll and private line service alternatives that are evaluated by customers. Generally, the end result is that the revenues received by Alascom from its private line services are significantly less than those that would have been received for the toll service alternative. However, Alascom does not have to share these reduced revenues with the local companies. Therefore, its net revenues may increase. The local companies find themselves unable to compete, losing settlement revenues that are important to their financial viability. They often are forced into a situation where all their large customers are subject to Alascom's offer of special services at special rates where the revenues will not have to be shared with the local companies. This process can ultimately force many small companies to the point of financial collapse.

In addition, Alascom negotiates with ATT for revenue settlements for Alaska interstate service. The results of these negotiations have a major influence on telecommunication development in Alaska. At present, interstate toll revenues for the state constitute approximately 60% of the total revenues (local intrastate and interstate) for the state. Thus, in a very real sense Alascom and ATT are negotiating the financial viability of the Alaskan telecommunication system and the course of its direction of its development.

The revenue settlement negotiations between RCA, Alascom and ATT have been taking place in the absence of detailed Alaska cost information. The cost information that is available is provided by ATT and Alascom. But this neglects the cost and traffic information from the local Alaska companies that is necessary for this settlement process. Thus, ATT and Alascom have sought other grounds for settlement.

In settlement negotiations ATT has resisted providing Alascom with more than 100% of Alaska two-way interstate revenues. ATT takes the position that any greater revenue settlement would represent a subsidy to Alaska, and ATT (i.e., the Lower 48 States) cannot subsidize Alaska.

The ATT position with regard to subsidy is directly contrary to the basic principles of geographical rate uniformity and revenue settlements among jurisdictions on the basis of actual costs incurred. These principles provide for revenue settlements to be determined independently from the actual revenues. At present, there are many small companies and even entire states in the Lower 48 States that receive revenues through the revenue settlement process that exceed the revenues generated by outgoing traffic in the areas served. As measured by traditional financial standards, these areas are being subsidized by the low cost areas of the Lower

48 States. The 100% of revenues limitation applied by ATT is an artifcial restriction that denies Alaska access to uniform nationwide interstate rates on the same basis as every other state.

In essence, ATT is placing an arbitrary limit on the extent of the subsidy that will be allowed. Moreover, this arbitrary limit is not based on a total dollar amount of subsidy. It is based on the revenues generated from traffic originating and terminating in the state. It is entirely possible that a calculation of the dollar amounts of subsidy on this basis would show that the subsidy for Alaska is less than it is for other states. The larger dollar amounts for other states would be permitted because the revenues generated by originating and terminating traffic in other states are greater.

The matter of revenue settlements as a basis for interstate rate integration has become too important an issue for Alascom and ATT to negotiate themselves. The FCC Joint Board presently examining the matter of cost separations for Alaska and the APUC are more appropriate fora for resolution of the revenue settlement issues. They should not be negotiated by private companies whose vested interests obviously differ from those of the public communicating to and from Alaska.

5. SUBSIDIES AND COMPETITION(7)

With the introduction of competition for intercity telecommunication services, what are the likely changes in the structure of internal subsidies within the national telecommunication system? Without question the most pervasive internal subsidies that are affecting the course of industry development are not the socially justified geographical cross-subsidies but rather the anti-competitive cross-subsidies whereby ATT's monopoly services subsidize its competitive services. ATT has employed such practices with a high degree of success over the past 20 years, despite the efforts of regulatory agencies to stop them. Unfortunately the APUC has not yet examined Alascom's profitability on a service by service basis to see if the monopoly toll service is subsidizing its specialized, potentially competitive services.

With regard to internal subsidies to meet social objectives, available studies have shown that local exchange service in the Lower 48 is not being subsidized, and, in fact, on some occasions is subsidizing competitive services. ATT's studies claiming that competition will require basic residential telephone rates to double have been found to be artificial and erroneous(8).

The central issue regarding internal subsidy for the implementation of social policy relates to jurisdictional cost separations between local and toll services. ATT, Alascom, and others claim that through jurisdictional cost separations and revenue settlements, the intercity toll services subsidize local services. If competition in intercity services is going to be encouraged, they argue, this subsidy through the jurisdictional cost separations process will have to be eliminated. This will result in higher local exchange rates, especially in rural areas and a compromise of the universal service objective. Thus, at the very time that Alaska is attempting to implement the universal service objective and take advantage of the internal subsidy opportunities within the separations and settlements process, pressures are increasing to shift a higher proportion of system costs to local exchanges.

Before addressing the issue as to whether competition really requires that this cost separations "subsidy" to local service be eliminated, it is important to determine in what respects it is a subsidy. In fact, analysis of the nature of telecommunication costs indicates quite clearly that an allocation of a portion of local costs to toll service does not represent subsidy. Rather, it simply represents a sharing of joint and common costs.

Local telephone exchanges are designed to supply both local and long distance services. The technical design of local facilities, including the customer terminal, the local loops, and local switching is conditioned by the requirements of meeting nationwide toll standards. A very high, but unidentified, portion of local exchange costs (including non-traffic sensitive costs) are incurred not to meet the requirements of local service, but rather to meet the requirements of long distance service. Most local exchange costs are joint and common costs, incurred for the common benefit of both local and long distance services.

Unfortunately, this has not been the way local costs have been perceived generally in the development of jurisdictional cost separations(9). Historically, ATT allocated no local costs to long distance. Long distance service received a free ride on the local exchange, even though many local exchanges had to incur substantial costs to upgrade to long distance standards. This is known as the Board-to-Board method of costing. It allocates to long distance service only those costs directly and solely associated with long distance. All costs incurred for the common benefit of local and long distance are allocated to local service.

A major portion of the history of telecommunications regulation over the past 50 years has been the continuing saga of state regulatory agencies and independent telephone companies attempting to negotiate the allocation of a portion of the common local exchange costs to interstate long distance service.

In 1930, a landmark decision by the United States Supreme Court in Smith vs. Illinois Bell (282 US 133) rejected the Board-to-Board method for purposes of rate regulation and established the principle of Station-to-Station costing. The court insisted that some recognition be given to the utilization of local exchange facilities in the supply of long distance toll services. The court ruled that the costs of local plant must be apportioned in some reasonable manner between local exchange and long distance services.

The allocation of local exchange costs to interstate long distance service is labelled "subsidy" by Alascom, and ATT. This is incorrect. It is a contribution to the coverage of joint and common costs, just as the remaining joint and common costs assigned to local service are a contribution. In fact, ATT operating company studies of the direct costs of their major classes of service within each state have consistently shown that local exchange service revenues always exceed their direct costs by substantial amounts. These studies show that it is the competitive private line and terminal service categories that more often than not fail to cover their direct cost(10).

Thus, it cannot be concluded that long distance service is subsidizing local service. Clearly, a return to Board-to-Board principles of costing would result in continuing subsidies of long distance services by local service, and subsidies of competitive services by basic monopoly services.

The current allocations of exchange costs to long distance services are not subsidies; nor would they be if the proportions were increased to achieve social policy objectives. Competition in the long distance market can take place just as effectively under a system of slightly higher as significantly lower charges for local exchange access. The important matter for competition is that the terms, conditions and charges for access be equally applicable to all competitors. In fact, it has been long demonstrated that competitive conditions will extend markets much further than monopoly conditions, thus requiring less subsidy to meet universal service objectives. Of course, with dominant monopoly carriers such as ATT and Alascom, the high degree of joint and common costs in exchange facilities provides substantial flexibility for the allocation of costs to meet public policy objectives, without compromising competitive policy objectives. It also provides ample room for maintaining any desired level of geographical uniformity of access charges.

6. ACHIEVING SUBSIDIES FOR SERVICE EXTENSION

The extension of the Alaska telecommunication system to encompass local service and provide improved access to long distance service for several hundred outlying communities will require that a larger portion of the local exchange common costs be allocated to long distance. Although such a change in cost allocation is not a subsidy in the true economic sense, it nevertheless will occur only as a result of hard negotiation on the part of the local companies as well as active policy direction from the APUC.

However, a shift in costs from local to long distance will not be fully successful unless at least a major portion of these costs can be shifted to the nationwide interstate cost pool. Alaska intrastate toll rates are now substantially higher than their interstate equivalents. Thus, if local extension must be achieved entirely at the expense of intrastate toll rates, local communities of interest will have been developed at the expense of the state community of interest. If Alaska is to get the benefit of geographical subsidies to high cost areas that exist in the nationwide telecommunications system in the Lower 48 States, it is going to have to negotiate access to the nationwide cost/revenue pool and acceptance of the transfer of these shifted exchange costs to the pool. Only then will Alaska be receiving the geographical subsidy that is available to high cost areas in the Lower 48 States. Here again, effective negotiation on behalf of the State is essential.

The subsidy amounts required for system extension in Alaska are very large when evaluated on a per capita to be served basis, but insignificant when compared to the magnitude of the costs and revenues for the nationwide telecommunications system. In 1979, the Governor's Office of Telecommunications for the State of Alaska estimated the required annual cost shift to interstate service at $15-27 million for rural service extension and a reduction in the most severe exchange rate disparities. An additional $23 million was estimated as necessary if the intrastate toll rate disparity were to be eliminated, i.e., intrastate rates reduced to the level of interstate rates(11). A recent (1981) study by the Stanford Research Institute for Alascom estimated that for 158 bush communities the establishment of local exchange service would result in annual cost deficiencies of $15-23 million(12).

The history of changes in cost separations under regulation demonstrates clearly that Alaska will get its subsidy from the nationwide telecommunications system to help cover the high cost of local service in rural Alaska only if it successfully negotiates for its subsidy rights in the face of the resisting economic interests of ATT and Alascom.

This approach to the resolution of the outstanding issues affecting Alaskan telecommunications calls for a major assertion of policy-making both by the APUC and by the State. It requires a continuing active policy planning and advocacy role on the part of the state to ensure that the APUC, the FCC, the various joint boards and Congress are provided with viable and justifiable alternatives for implementing Alaska's subsidy rights. Only by this approach can Alaska assert itself as a major determinant of the policies that will direct its future in telecommunication.

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Summary

TELEMATICS: ALASKA AND THE INFORMATION FRONTIER

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Abstract

New markets for telecommunications services are developing in Alaska. Office information systems, enhanced voice communications and teleconferencing are fast growing application areas. Market supply and demand for these "Telematic" services are clearly on the demand side in Alaska. Successful resource development, economic growth and Alaska's emergence as a new player in the world energy arena depend on the adequate supply of information based services. This paper reviews these new telematic service markets and their impact in the Alaskan telecommunications marketplace.

Introduction

Any discussion of telecommunications advances in the State of Alaska must take into account some of the overriding historical disparities that have plagued Alaska from it's earliest territorial days. Conservatively, Alaska is operating at the approximate levels of service for telecommunications programs that were provided in the contiguous forty-eight states in the late 1950's and early 1960's. Despite rapid changes that have been thrust on this political unit in the last decade the overall model that applies is one of a lesser developed country, possessing vast resources, a thinly distributed population, limited technological availability, a recently acquired democratic tradition, and newly gained institutional wealth that can be directed to effecting necessary change.

In the immediately preceding ten year period, four landmark events have occured which are rapidly propelling the state into a position of international prominence and accelerated technologic change. In order these are:

1. Passage of the Alaska Native Claims Settlement Act (ANCSA) in 1971, mandating the formation of native owned corporations holding hundreds of thousands of acres of development land, and receiving close to one billion dollars in state and federal reparations monies for private investment and growth.
2. Passage of oil and gas taxation legislation and formation of a permanent state investment fund for such surpluses generated, to be held and invested in perpetuity for the citizenry of the state.
3. Completion of the construction of a multi-billion dollar oil transportation system to carry oil from the Arctic to more conventional petrochemical distribution systems, thus "unlocking" Alaska's subsurface wealth.
4. Reinvestment and exploration of renewable resource development alternatives in agriculture, aquaculture, timber and game management.

Underscoring each of these socio-economic benchmarks has been extensive expenditure to create a governmental infrastructure in the areas where none has existed.

In a twelve year period the state has seen a rise in spending from approximately $900 Million in 1969, to a record high of $2.5 Billion in FY 1981-1982, for both operational and capital expenses. It is in this environment that innovation in telecommunications and more specifically "telematics" is to be examined.

Part of the dynamic of technologic advance in Alaska has been the influence of the regulated common-carrier. However, critics of the political process also point out that it has also been the excessive intervention by government that has retarded the communications growth.

The overall expansion of state spending in the provision of services and in mandating capital construction has effectively limited the ability of competing businesses to enter new growth markets.

This retarding effect has been limited, however, by the implementation of Executive Order #50, in the Spring of 1981. The order consolidated previously dispersed State telecommunications functions into a single administrative agency and, more importantly, required that the new agency work closely with the private sector to expand the scope of services supplied to Alaskans.

Coupled with some deregulatory efforts by the Alaska Legislature in 1979 and 1980, and a pending overall limitation on state spending (to be voted on in 1982), the development and investment climate for telecommunications appears to be improving.

While it is obviously not the intention of this paper to review all of the political dynamics of technologic growth, it has been necessary to re-state some of these historical relationships, to more clearly indicate trends for the 1980's.

I). Market Growth in Carrier Services

In 1971, RCA Globcom purchased the Alaska Communications System (ACS) from the federal government, telecommunications accessibility was limited to local telephone services provided by municipalities and small telco's. After RCA Alascom began operations, a long distance network began to take shape that was a combination of terrestrial microwave, tropo scatter links and domestic satellite interconnects. The telephone market was limited to "black phone" technology and a few low speed teletype circuits referred to as "pony loops".

By 1979, when RCA sold Alascom to Pacific Power and Light, a Portland based power company, Alaska was interconnected by a network of small earth stations mainly financed by state government. Interconnect key and PBX systems were being marketed by several companies in Anchorage, and Fairbanks. The data terminal market was expanding. Alaska's major economic centers: Anchorage, Fairbanks and Juneau began to rely heavily on telecommunications as a method for business communication. Office information systems, communicating word processors, facsimile and electronic mail systems began to proliferate. Several large nodal data communications networks were constructed by state government. The University of Alaska Computer Network (UACN), and the Department of Education Educational Telecommunications for Alaska (ETA) electronic mail system were used by government agencies to communicate with remote local communities and between government agencies (1). Similarly other data networks were expanded to handle Legislative information, public safety and marine transportation (2).

The expansion of government telecommunications also correlated to an expanded business communications market. "Value added" data communications services were introduced when Telenet and Tymnet, in a joint tariff arrangement with Alascom, began offering "off-shore" access to computer resources. Telenet and Tymnet were followed into the long distance market by the entry of DHL corporation who was granted "resale" authority in 1981 to operate a switched facsimile network in 50 cities nationwide, as well as Alaska and Hawaii. DHL entry was followed in mid-1981 by the announcement that an Anchorage based firm, General Communications Inc., had been granted 214 authority to construct a satellite based network for private line services linking Anchorage, Fairbanks and Juneau.

GCI which intends to bring up its system in 1982, will utilize Time-Division Multiple Access technology to link the network nodes allowing for greater space segment efficiency which will be passed through to consumers in the form of distance insensitive tariffs not available through Alascom.

Other transmission services have also been granted authority to operate. Meteor Data Inc. another Anchorage based communications company under a special radio common carrier license is now offering low speed data communications through a meteor scatter propagation system capable of linking remote monitoring sites to a centralized computer. Meteor Data is now connecting 50 state operated bush airports to a FAA computer for updating aviation weather forecasts.

Another resale carrier has applied for 214 authority to provide a data distribution service using WESTAR. Equatorial Communications, of Sunnyvale California utilizes a spread spectrum technique to link receive only earth terminals (2 foot aperature) for stock reports, commodities information, etc.

Countering this influx of new carriers, Alascom is agressively pursuing a firm hold on space segment. In a recent deal with RCA Americom, Alascom agreed to buy the SATCOM V satellite and lease back unused capacity to Americom. Alascom also has begun offering a new "toll concentration" service in bush villages with single line service. Alascom is now tariffed to install a small digital telephone switch that connects local village subscriber into the L.D. toll network. Local calling currently is not offered.

In total perspective the market for long distance services appears to be able to accomodate all entrants. With long line communications becoming more available a market for enhanced "end point" services is developing.

II). Enhanced Market Applications

One of the more desirable enhanced market applications available to Alaskans is (multi-point) teleconferencing. Extremes of climate, distance and culture have made it very difficult to effect common socio-political or economic goals, without substantial

travel to remote locations, or the equally expensive convening of large gatherings of individuals for more formal conferences. As a result, both state and private entities have begun to investigate full audio and videoconferencing.

In a single executive agency, the projected, budgeted travel for FY 82 was set at $1,280,600 to discharge both development and public protection services. Concurrently, the same agency was allocated roughly $650,000 for all communications. The combined total of nearly $2 Million will be used to administer loan programs, special development programs, investigations, energy conservation efforts and the like (3).

Using this agency as an exemplary average, and multiplying the cost times fifteen executive departments the total expenditures approach $20 Million per year for essential travel, $10 Million for communications, for an annual state expenditure of at least $30 Million dollars. This figure does not include similar incurred costs for quasi-judicial; non-profit or public corporation activity also performed in the public interest.

Generally, multi-point conferencing can serve as a cost-effective adjunct to administrative travel. While face-to-face contact is an essential element of governmental service delivery or non-profit health corporation management, effective control of such structures can be maintained by reliable long distance communications.

Decentralization of government is often discussed as a means of maximizing citizen involvement and minimizing the negative growth of bureaucracies.

Given that the political and economic power structures of Alaska are in order: State Government; Regional Profit-making corporations; Municipal governments; Regional non-profit corporations; urban commercial and/or financial interest groups, it then follows that decision making, community education and regional consensus building, can be done using an extended teleconferencing model.

With the further sophistication of ethnic populations or secondary growth centers as stimulated either by native corporate policies (ANCSA) or by directed governmental influence, the implications for public and private teleconferencing become enormous.

One such example is as follows:

> Assume a regional non-profit corporation assembled to provide preventive medicine training; emergency medical intervention; job counselling and recruitment; and grants in aid for community sewage treatment/water purification programs.
>
> The corporation encompasses a geographic region roughly the size of the country of Peru, but with only 50 communities with an average population of 175 people. Within the corporate environs there are two population centers with better than 500 people.
>
> In this region the principal transportation modes in the region are navigable rivers and by light aircraft, and less than three hundred miles of connected roads exist.
>
> Close family and kinship communications patterns exist between communities on the river courses, but active telecommunications services amount to one Satellite Earth Station telephone in each village, HF/VHF medical radios and an occasional air-to-ground radio.
>
> As a final component of the example, add climatic extremes of -55°F/-48°C to +85°F/29.4°C, and seasonal light and dark periods of up to 22 hour lengths.
>
> Principal economic activity within the region is traditional subsistence gathering, limited seasonal construction and subsidized government administration, with median annual incomes hovering at or near $3,000.

Although other variables could be included, the basic model represents any of a number of rural Alaskan environments. It is apparent on the surface that for the corporation to reasonably discharge its responsibilities it will require an extraordinary commitment to travel in hazardous circumstances.

However, as the external forces of "for profit" corporate development and government supported "infrastructure building" continue, telematic services should also expand to offset the restrictions of a hostile environment, limited human resources, or artificially imposed time or money constraints.

III). New Directions: The Electronic Megalopolis

Almost twenty years ago Canadian Professor Marshall McLuhan propounded the theory of the "Global Village." In the ensuing years communications theorists such as Herman Kahn, Alvin Toffler, Paul Baran, and science fiction author John Brunner have further refined the concepts of mass communications and technology to create the

new term of the Electronic Megalopolis.

Within this decade the most remote villages, logging or fishing camps will be woven into the fabric of contemporary communications technology. Telematics and the admixture of entertainment/educational television, full-motion video conferencing, computer assisted interactive instruction and Space Invaders will be available to an Inuit Eskimo girl on the western coast of Alaska, programmed by specialists in Birmingham, Alabama, and carried on Direct Broadcast Satellites.

What is needed now, however, is the blending of government assistance, in-system delivery, unrestricted access for emerging user groups, and an industry oriented to providing a reasonably priced, quality service to the small user. The Alaskan case study imperfectly reflects the larger trends of a burgeoning international pattern in that little has been done to document change as it occurs. It is insufficient to predict growth without clearly identifying the operational elements. Perhaps the greatest irony that exists is that where "telematics" offers powerful tools of public and private growth, such intelligence remains untallyed, undocumented, and in the hands of a few.

(1) Alaska Telecommunications Systems Development - Meeting State Needs Through Appropriate Application of Telecommunications, S.P. Browne, Exposition Proceedings, Intelcom 79, Dallas, Texas, February 1979

(2) Alaska's Legislative Teleconference Network - Why it Works, Sioux Plummer, Conference Proceedings, Pacific Telecommunications Conference '81 P. B8-1, January, 1981

(3) Source: Dept. of Commerce and Economic Development Summary of Appropriations - FY 1982. Alaska State Legislature

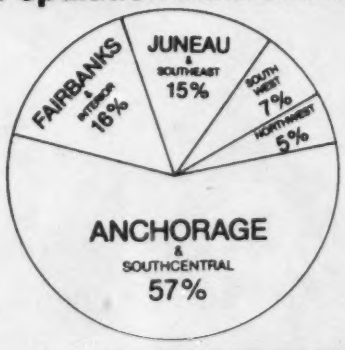
ALASKA'S POPULATION AND ECONOMIC PROFILE

ALASKA:
The largest state with the smallest population in the U.S.

ALASKA: Urban Population Concentration

Anchorage ADI	217,000	54%
Fairbanks ADI	59,500	15%
Juneau ADI	19,500	5%
TOTAL	296,000	74%

ALASKA: Population Distribution



ALASKA: Racial Mix

	ALASKA	U.S. AVERAGE
White	77%	83%
Alaska Native and American Indian	16%	0.6%
Black	3.4%	11.7%
Asian and Pacific Islanders	2%	1.5%
Other	1.5%	3%

ALASKA: 2nd Youngest State Population in U.S.

UTAH	24.2 years
ALASKA	26.2 years
FLORIDA	34.7 years

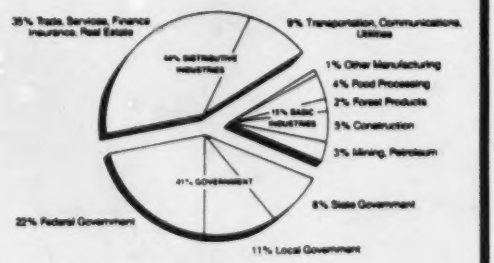
ALASKA: Air Transportation

10,404 Certified Pilots
7,104 Small Planes
37 Airlines Use Anchorage International Airport

ALASKA: Fishing

31,963 State Permits
18,761 Fishermen
600 In-State Processors

ALASKA: Minerals

Gold
Copper
Tin
Zinc
Lead
Silver
Coal
Jade
Oil

ALASKA: Employment Mix